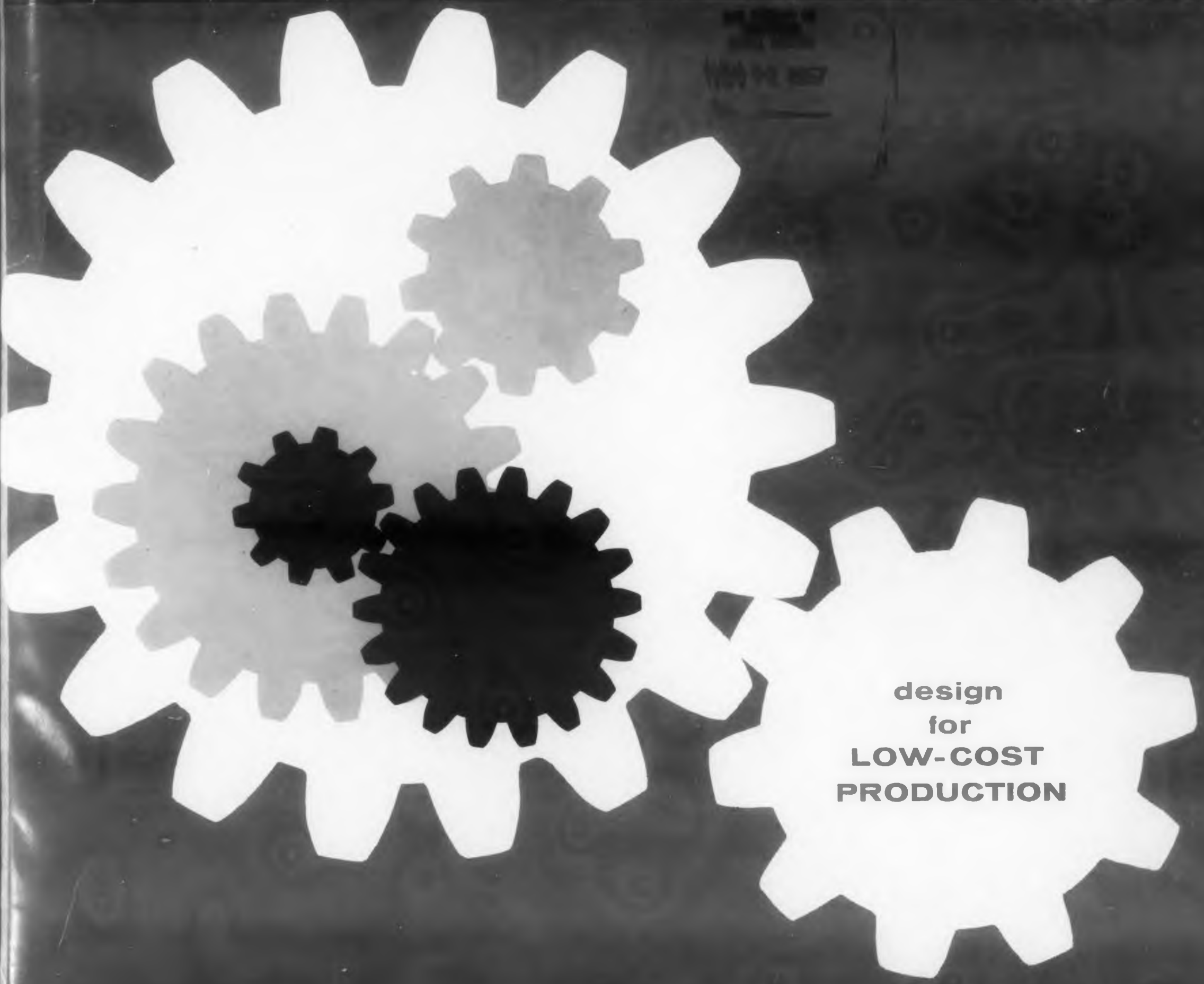


ELECTRONIC DESIGN

NOVEMBER 1967



design
for
**LOW-COST
PRODUCTION**

NEW IRC®

Distributed Parameter Delay Lines

FEATURE UNIFORMITY, STABILITY AND LOW COST

IRC's extensive mass production experience and technique in the manufacture of continuous lengths of wire wound resistive elements have now been utilized to produce a uniform high-quality, low-cost, distributed-constant delay line. Simplicity of design permits close control of electrical characteristics even to providing, in many applications, unusual phase characteristics to meet customers' special requirements.

Encapsulation in phenolic impregnated rigid tubes with axial leads assures good stability under adverse environmental conditions. These delay lines are well suited for either point-to-point wiring or printed board applications.

If you have an application for distributed constant delay lines, we will be pleased to review your requirements. Send coupon for full details.

Features

TIME DELAY 0.2 to 1.0 microseconds
IMPEDANCE 500 to 2500 ohms standard; higher and lower are available on special request
BANDWIDTH 3.5 MC and greater as required
TEST VOLTAGE 300 volts
OPERATING TEMPERATURE 65°C

Insulated Composition Resistors • Deposited and Boron Carbon Precursors • Power Resistors • Voltmeter Multipliers • Ultra HF and Hi-Voltage Resistors • Potentiometers

Low Wattage Wire Wounds • Resistance Strips and Discs • Selenium Rectifiers and Diodes • Hermetic Sealing Terminals • Insulated Chokes • Precision Wire Wounds • Attenuators



CIRCLE 1 ON READER-SERVICE CARD

INTERNATIONAL RESISTANCE CO.

Dept. 266 401 N. Broad St., Phila. 8, Pa.
In Canada: International Resistance Co., Ltd.,
Toronto, Licensee

Send technical data Bulletin S-2 on the new IRC Distributed Parameter Delay Lines.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Staff

Editor Edward E. Grazdo

Managing Editor J. A. Lippke

Sr. Associate Editor E. T. Ebersol, Jr.
Associate Editor G. H. Rostky

Assistant Editors S. Dresner
P. J. Lohey
T. E. Mount
D. S. Viebig
E. T. Blake
T. E. Melville
M. M. Robinson

Contributing Editors S. H. Hubelbank
J. M. Montstream
J. G. Adashko
E. Brenner

Editorial Assistants F. Muehleck
M. S. Buckley
N. A. Leftwich

Art Director S. Sussman
Asst. Art Director R. A. Schulze
Art Assistant S. F. Richter

Production Manager T. V. Sedita
Asst. Production Manager M. W. Baron
Production Assistant J. Siegel
Business Manager P. L. Canfield
Circulation Manager N. M. Elton
Asst. Circulation Manager C. J. Johnson
Reader Service E. Hession

Co-Publishers

T. Richard Gascoigne
James S. Mulholland, Jr.

Advertising Sales Manager

Bryce Gray, Jr.

Advertising Representatives

New York: Owen A. Kean
19 E. 62nd St. Robert W. Gascoigne
TEmpleton 8-1940 Harley F. Macomber
Blair McClenahan
Richard Parker

Chicago: Berry Conner Jr.
664 N. Michigan Ave. Fred T. Bruce
SUperior 7-8054

Los Angeles: Robert E. Ahrens
5720 Wilshire Blvd. John Quillman
WEbster 8-3881 Stanley I. Ehrenclou

Subscription Policy

ELECTRONIC DESIGN is circulated only to qualified electronic design engineers of U. S. manufacturing companies, industrial consultants, and government agencies.

If design for manufacturing is your responsibility you qualify for subscription without charge provided you send us the following information on your company's letter head: Your name and engineering title, your company's main products, and description of your design duties. The letter must be signed by you personally. Any address changes for old subscribers necessitates a restatement of these qualifications.

Subscription rate for non-qualified subscribers—\$12.00 for 1 year only.

Hayden Publishing Company, Inc.
19 East 62nd Street
New York 21, New York

◀ CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC DESIGN

Contents

Vol. 5, No. 22
November 15, 1957

Design for Low-Cost Production (Cover)	30		
Editorial	4		
Engineering Review	5		
Washington Report	20		
Features			
The Electronic Designer's Responsibility for Low-Cost Production, F. F. Richards	70		
Human Factors in Low-Cost Production	76		
Standardization and Cost	76		
Decreasing the Cost of Instruction Manuals, P. Billick	77		
Sheet Metal Design, S. A. DeCosmo	78		
Standard "Cans" Cut Enclosure Costs	90		
Prototype Design Compatible with Production, R. E. Gildroy	96		
Versatile Low-Cost Tester	110		
Silicon Unijunction Transistor	112		
Design for Low-Cost Production (A Staff Report)			
1. Planning for Low-Cost Production	30		
2. Prototype Design Compatible with Production	34		
3. Save Costs in Drafting	36		
4. Standardization	40		
5. Selecting Materials and Components for Low-Cost Production	44		
6. Labor Savings with Printed Wiring	46		
7. Sheet Metal Design	50		
8. Costs Savings with Plastics	52		
9. Packaging for Economy	54		
10. Process Evaluation and Value Analysis	56		
11. Hand Assembly vs Automatic Production	62		
12. Designs for Low-Cost Production	64		
Production Equipment			
Automatic Terminal Capping Machine	74		
Blow-Loader—Key to Small Parts Handling	84		
Vacuum Metallizing Unit	86		
Ultrasonic Machining of Ferrite	94		
Equipment for Low-Cost Production	98		
Design Forum			
Reliable Vibrator Replacement	88		
Amplifier in a Thermos Bottle	92		
Ideas for Design			
High Vacuum Impregnation Reduces Expensive Rejects	164		
Save Money on Cold Headed Parts	166		
Russian Translations			
What the Russians Are Writing	190		
Video Coupling Network Nomogram	195		
Abstracts			
Band Pass Surface Waveguide	198		
Pulse Type Cathode-Ray Tubes	199		
Departments			
Meetings	24	Patents	184
New Products	114	Books	188
New Literature	154	Standards & Specs	200
Report Briefs	178	Careers	206
Advertisers' Index	208		

FOR DATA PROCESSING COMPONENTS AND SYSTEMS

SPECIFY POTTER

Potter instruments and systems are unexcelled in reliability, accuracy and flexibility. The equipment shown is typical of many more available as individual components or in integrated systems to meet specific requirements.

Write for brochure describing these and other Potter units, including special products. For detailed technical specifications on any of the Potter Products listed above, contact your Potter Representative or the factory.

DATA-HANDLING EQUIPMENT



Digital Magnetic
Tape Handlers



Perforated
Tape Readers



"Quick Look" Recorders



Record-
Playback
Head
Assemblies



Record-Playback Amplifiers

PRESET INTERVAL GENERATORS



Preset Interval and Delay Generators

HIGH SPEED ACCESS REGISTERS



Ten-Bit Parallel
Output (Serial Input) Using Magnistors



Ten-Bit Serial Output
(Parallel Input) Using Magnistors



Six-Bit Digital
Comparator Using Magnistors



POTTER INSTRUMENT COMPANY, INC.

SUNNYSIDE BOULEVARD

PLAINVIEW, N. Y.

CIRCLE 2 ON READER-SERVICE CARD

BPA

ELECTRONIC DESIGN is published semi-monthly by Hayden Publishing Company, Inc., 19 E. 62nd Street, New York 21, N. Y., T. Richard Gascoigne, President; James S. Mulholland Jr., Vice-President & Treasurer and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Acceptance under section 34.64 P. L. & R. authorized. Copyrighted 1957 Hayden Publishing Company, Inc. 30,000 Copies this issue.

NBP



SEMICONDUCTOR DIODES and RECTIFIERS



All illustrations are actual size

DIFFUSED JUNCTION SILICON RECTIFIERS

A STUD TYPE

B WIRE-IN TYPE

Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV μ A	Type	Peak Inverse Volts	Average Rectified Current Amps. (135°C)	Reverse Current (max.) at PIV μ A	Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV μ A
CK846	100	1.0	2	1N253	95	1.0	10	1N537	100	0.25	2
CK847	200	1.0	2	1N254	190	0.4	10	1N538	200	0.25	2
CK848	300	1.0	2	1N255	380	0.4	10	1N539	300	0.25	2
CK849	400	1.0	2	1N256	570	0.2	20	1N540	400	0.25	2
CK850	500	1.0	2					CK844	500	0.25	2
CK851	600	1.0	2					CK845	600	0.25	2

SILICON POWER RECTIFIERS

BONDED SILICON DIODES

Type	Peak Inverse Volts	Average Rectified Current Amps. (125°C*)	Reverse Current (max.) at PIV mAdc
CK774	25	5	5
CK775	60	5	5
CK775-1	125	5	5
CK776	200	5	5
CK777	325	5	5

*Case Temperature

Type	Peak Inverse Volts	Forward Current (min.) at +1V mAdc	Average Rectified Current mAdc (25°C)	Reverse Current μ A at V
1N300	15	15	65	0.001 10
1N300A	15	30	80	0.001 10
1N432	40	10	55	0.005 10
1N432A	40	20	70	0.005 10
1N301	70	5	45	0.05 50
1N301A	70	18	65	0.05 50
1N460	90	5	45	0.1 75
1N460A	90	15	60	0.1 75
1N303	125	3	40	0.1 100
1N303A	125	12	55	0.1 100
1N433	145	3	40	0.1 125
1N433A	145	10	50	0.1 125
1N434	180	2	35	0.1 150
1N434A	180	7	45	0.1 150
1N302	225	1	30	0.2 200
1N302A	225	5	40	0.2 200
CK863	300	1	20	0.3 275
CK863A	300	3	30	0.3 275

GOLD BONDED GERMANIUM DIODES

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current at -10V μ A
1N305	60	125	2
1N306	15	150	2
1N307	125	50	5

GENERAL PURPOSE GERMANIUM DIODES

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current μ A at V
1N66	60	50	800 -50
1N67	80	35	50 -50
1N68	100	35	625 -100
1N294	60	50	800 -50
1N297	80	35	100 -50
1N298	70	50	250 -40
VHF and UHF			
1N295	40	35	200 -10
CK715	40	35	



SEMICONDUCTOR DIVISION

Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

NEWTON, MASS.: 55 Chapel St. • Bigelow 4-7500
 NEW YORK: 589 Fifth Ave. • PLaza 9-3900
 CHICAGO: 9501 Grand Ave., Franklin Park • TUxedo 9-5400
 LOS ANGELES: 5236 Santa Monica Blvd. • NOrmandy 5-4221

CIRCLE 3 ON READER-SERVICE CARD

Editorial

Don't Kid Yourself!

Don't kid yourself that the electronic designer's job is done and *finished* strictly by achieving a functional working model. Just as secretaries can make or break an executive, so can a design engineering group make or break a company financially. The "hidden" engineering costs are often hard to put a finger on; yet, they may bring up the cost of the end product prohibitively.

Don't kid yourself—Right at the outset of a design, planning costs begin to enter the picture. The way a design is conceived often determines what it will cost to produce. Production Engineering departments often "bail out" the designer. Yet, they are often costly and an admission that the electronic engineers don't assume responsibility for production costs, or are incapable of doing so because of a lack of essential production knowledge. In some instances this Production Engineering group may be necessary; but

Don't kid yourself. Redesigning is a costly operation; and rarely produces an end product as well designed either functionally or cost-wise as can be achieved when methods of production are considered at the outset of design planning. The electronic designer's job is complicated by the need to know more than just how to produce functional circuitry. He should be able to take "project" responsibility. This means that he must take responsibility for both the quality and the cost of the end product.

Don't kid yourself—The designer needs to know what shapes in sheet metal cost the least to form; how close one can put a hole of accurate tolerances through the edge of a chassis without an additional drilling operation; what materials are cheapest for the structural and electrical characteristics required; how a design affects the ability to automate an operation in production; how the design is affected by quantity of production runs.

Don't kid yourself—A good designer is valuable because he not only can design good functional equipment, but he can squeeze every last cent out of the cost of production so it can be sold at lowest possible cost consistent with the functional requirements established for it. Knowledge of low-cost production design is not easy to obtain in text books. Therefore, we suggest a careful reading of the articles and staff report in this issue on "Designing For Low Cost Production." We also suggest as much first-hand experience as possible. The designer cannot ignore the production phases of our "business."

Don't kid yourself.—ETE

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.



Aluminum Soldering Simplified: Simple and effective techniques for soldering aluminum and its alloys as well as galvanized metals have been developed by the Bell Telephone Laboratories. Employing an inexpensive and stable zinc base alloy, the technique requires no flux or abrasion. Long term stability and strong stable joints are assured by the exclusion from the zinc base alloy of deleterious elements such as lead, tin, bismuth and cadmium.

In aluminum soldering, it is unnecessary to remove rolling mill oils or surface oxide from the area to be wetted. A single stroke of the solder stick across the heated aluminum surface causes the solder to penetrate the oxide and wet the aluminum. The oxide coating is raised and may be wiped aside.

Super High Speed Memory

A super high speed memory device which can respond in a hundred millionth of a second has been announced by the International Business Machines Corp. Using a miniature printed circuit of metallic lead at temperatures close to absolute zero (-459.7 F) the device may hold great promise for tomorrow's high speed, high capacity electronic computers.

Developmental model test memory cells have been made with switching speeds of approximately $0.01 \mu\text{sec}$, about 100 times faster than ferrite core memories. These cells require about 150 ma of drive current compared with 400 ma for ferrite core memories. A further advantage of these cryogenic memory units is the absence of delta noise normally found in core memory arrays. This is the consequence of a separation of the drive and sense wires by means of a perfectly conducting plane, the lead film.

Further advantage of these memory cells for computer applications lies in the packaging into extremely small arrays by means of vacuum metallizing techniques capable of producing film thickness on the order of 900 A.

One experimental model memory cell contains a superconductive film with a crossbar of superconductive material vacuum-metallized across a hole, and placed in electrical contact with the film. Driving is accomplished by means of drive wires placed parallel to the crossbar. A sense wire located beneath the film, detects flux changes.

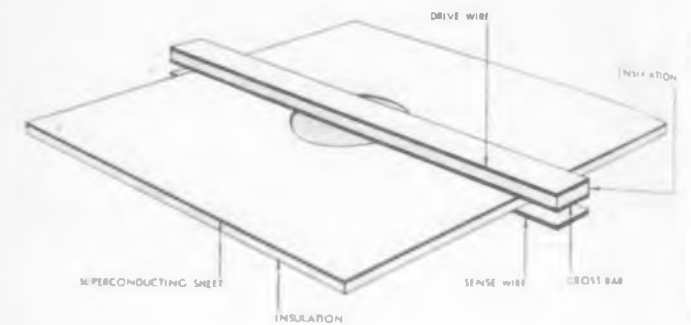
When the memory cell is pulsed at low rise times, a current is set up in the crossbar, establishing a field to oppose that of the drive. The geometry of the cell prevents the net flux from linking the crossbar. The crossbar becomes normally conducting as soon as the induced current



IBM Journal of Research and Development

This super high speed memory cell operates on the principle of trapped flux in superconductors. A superconducting cell is illustrated showing the detail of the U-shaped Y drive wire. In this cell the switching function is interpreted on the basis of destruction of the superconducting state by a critical current density rather than a critical field density.

Engineering Review



Drawing showing the geometry of a test model of a memory cell. Flux-trapping functions of the imperfections of the film are provided by a hole in the superconducting film.

reaches its critical value. At this point, a portion of the magnetic flux penetrates the crossbar, and the induced supercurrent decays slightly. The crossbar then becomes superconducting inasmuch as the current is now below the critical value. To the extent that the decaying current does not cause significant heating of the crossbar, the above sequence is repeated until all of the field above the critical level has penetrated the crossbar.

The flux now threads the hole and links the superconductive crossbar. Since with zero resistance, the net change of the field linking the crossbar must be zero while the applied pulse is turned off, the induced current begins to decrease. The induced current decreases to zero and then begins to build up in the opposite direction to sustain the flux at a constant value. In the steady state condition, this current will remain at some constant amplitude as long as the applied current is zero.

If the rise time of the current pulse is decreased, the flux penetrates the crossbar more rapidly than is true of the condition described above, apparently accompanied by Joule heating and a rise in temperature. Eddy-current heating seems to lower the critical field as well as to restore more resistance. At this point the process becomes regenerative and the resulting observations can be explained by a temperature rise which is extremely rapid (test results indicate that the temperature reaches its peak value in not more than .01 μ secs). The temperature then decreases, as evidenced by the successively increasing values of the critical current carrying capacity of the crossbar.

IN AVIONIC EQUIPMENT, WHY LOAD ON EXTRA WEIGHT?

use Clifton Precision Size 8 Synchros

WEIGHT 32 GRAMS

SYNCHRO FUNCTION	CPPC TYPE	ROTOR AS PRIMARY					STATOR AS PRIMARY					D. C. RESISTANCE		IMPEDANCE						
		Input Voltage (400~)	Input Current (Amps)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/dog)	Phase Shift (dog/lead)	Input Voltage (400~)	Input Current (Amps)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/dog)	Phase Shift (dog/lead)	Rotor (Ohms)	Stator (Ohms)	Z _{rs} (Ohms)	Z _{ss} (Ohms)	Z _{rs} (Ohms)	Max. Hall Voltage (MV)	Max. Error (Min.)
Torque Transmitter	CGC 8 A 7	26	100	5	11.8	206	8	—	—	—	—	—	37	12	54 + j260	12 + j45	80 + j20	30	7	
Control Transmitter	CTC 8 A 1	—	—	—	—	—	—	11.8	090	2	23.5	410	9	150	24	212 + j684	22 + j115	246 + j60	30	7
Control Transformer	CTC 8 A 4	—	—	—	—	—	—	11.8	029	08	22.5	390	8	389	64	560 + j1860	90 + j340	640 + j190	30	7
Torque Receiver	CRC 8 A 1	26	100	5	11.8	206	8	—	—	—	—	—	37	12	54 + j260	12 + j45	80 + j20	30	30 sp.	
Electrical Resolver	CSC 8 A 1	26	038	42	10.8	190	20	11.8	078	26	23.2	400	11	230	27	286 + j620	45 + j148	350 + j75	30	7
Electrical Resolver	CSC 8 A 4	26	038	42	26	454	20	26	030	23	21.5	375	12	230	170	286 + j620	250 + j830	350 + j75	30	7
Control Differential	CDC 8 A 1	—	—	—	—	—	—	11.8	085	21	11.8	206	9	36	25	38 + j122	27 + j120	48 + j14	30	7
Vector Resolver	CVC 8 A 1	26	057	34	11.8	206	10.2	—	—	—	—	—	78	27	103 + j440	8 + j30	—	30	7	

LOOK TO CPCC FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS CO. INC.

cpcc

Clifton Heights, Pa.

CIRCLE 4 ON READER-SERVICE CARD

When all the flux has penetrated the bar, the temperature in the bar then begins to decrease. Investigations reveal that the time factor for the temperature of the bar to decrease to essentially the ambient is a function of the thickness of the film and the substrate.

The operation of the test memory cell does not depend on slow rising or falling pulses as long as the width of the pulse is greater than the heat relaxation time. In addition, the amplitude of the circulating current must be less than the threshold. Exceeding the threshold would cause a heating problem during the fall time, which would destroy the stored information.

Additional information on these memory cells may be obtained from "Trapped-Flux Superconducting Memory," J. W. Crowe, and "An Analysis of the Operation of a Persistent-Supercurrent Memory Cell," R. L. Garwin, contained in the *IBM Journal of Research and Development*, Oct. 1957.



PROBLEM: Wave-form photography

Attempts at photographing elusive wave forms on conventional scopes have been, hitherto, a prodigious waste of time and film. Now, hair-trigger photography can be a thing of the past.

SOLUTION: a Hughes MEMO-SCOPE® Oscilloscope. What does the MEMO-SCOPE do that no other scope can? A storage-type oscilloscope, it can instantly "freeze" any number of selected traces until intentionally erased. Photos may thus be taken at leisure—with just one camera setting—one exposure—for each permanent record required. No tedious repetition. No more wasted film. The resultant savings can quickly pay for this "transient recorder with a memory."

If you haven't yet seen a demonstration of the MEMO-SCOPE Oscilloscope, ask a Hughes representative to arrange one. He'll quickly do so—at your convenience—in your area. Please send for Application Data Sheets Nos. MSAD-A1 and MSAD-A2. Write to:

HUGHES PRODUCTS
MEMO-SCOPE Oscilloscope
International Airport Station, Los Angeles 45, California



HUGHES MEMO-SCOPE OSCILLOSCOPE
STORAGE TUBE—5-inch diameter Memotron® Direct Display Cathode Ray Storage Tube. Writing speed for storage: 125,000 inches per second. The optional Speed Enhancement Feature multiplies writing speed approximately four times.
OSCILLOSCOPE—Controls: intensity, focus and astigmatism are provided for conventional adjustments. Flood gun, storage and erasure permit regulation of the storage performance.
PREAMPLIFIER TYPE WB/4—Standard equipment with the described instrument. Frequency response: Vertical, DC to 250 KC down 3 db at 250 KC. Sensitivity: 10 millivolts to 50 volts per division (0.33") in 9 calibrated steps. Or, it is adjustable continuously with a 10:1 vernier.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

CIRCLE 5 ON READER-SERVICE CARD



Electronic Coder: An electronic coder to be used in the transmission of scrambled signals over the Skiatron tall television system is shown here being assembled in the laboratories of the Skiatron Electronics & Television Corporation, New York City. The TV signals transmitted through this unit are unscrambled by the Skiatron decoder, which is attached to the receiving set. The decoder goes into operation when the subscriber inserts an electronic program card and presses one button.



Ceramic Radome for High Heat: A high alumina ceramic radome has been developed to withstand the high temperatures encountered when a missile re-enters the atmosphere at very high speeds. The Air Research and Development Command of Baltimore, Md. recently announced that Gadding, McBean and Co. had completed the first ten prototype radomes under ARDC contract. One step in the new process is illustrated, wherein a protective rubber bag is placed over the ceramic radome prior to immersion in a 30,000 psi pressure chamber. The radome, which is formed on a steel shell must have exacting electrical, thermal, and mechanical properties.

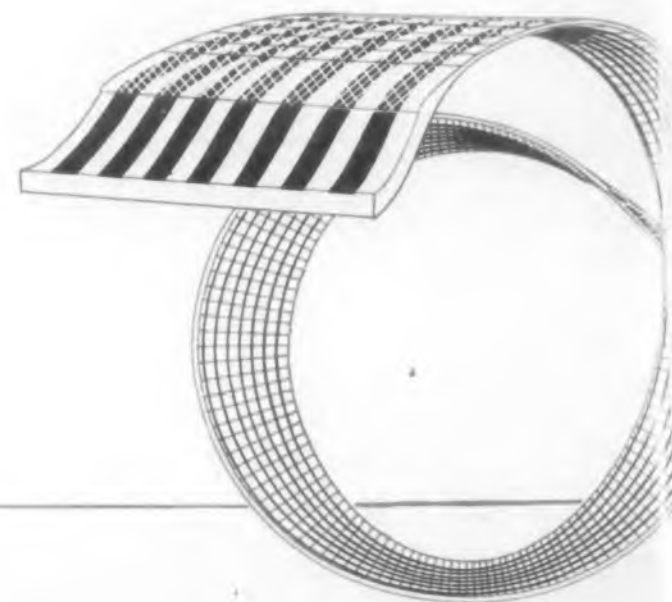
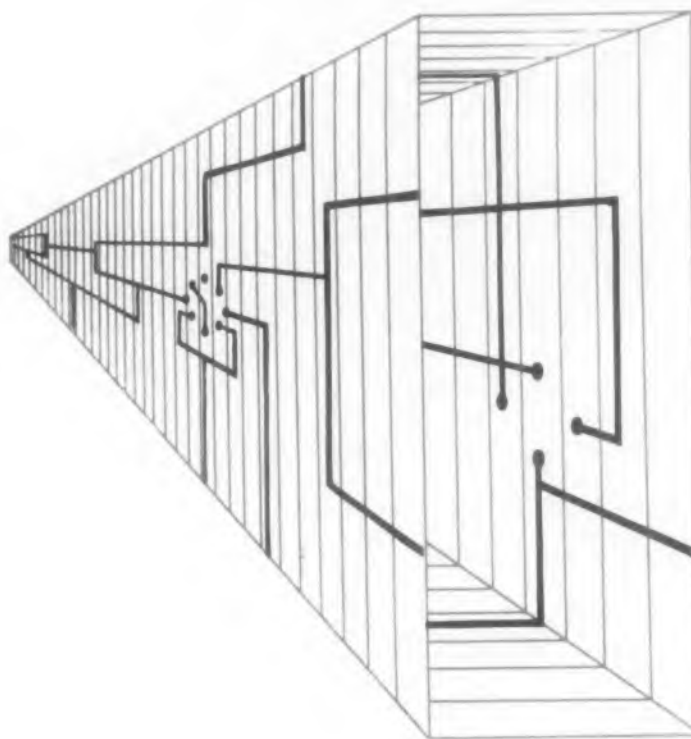
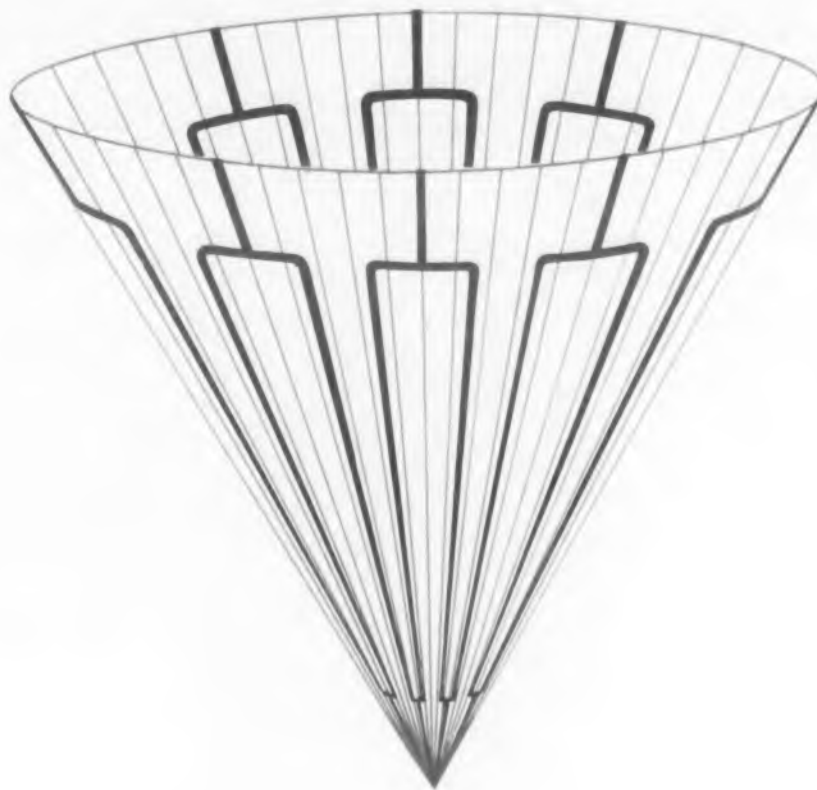
Ready for Sputnik

When Sputnik first crashed into world headlines, very few laboratories in the U.S. were prepared to receive the radio broadcasts from the Russian "moon." The Boulder Laboratories of the National Bureau of Standards was one of the first to set up a crash program to obtain information from Sputnik.

According to Ralph J. Slutz, Chief of the Radio Propagation Physics Division, "The Russians have presented us with an unexpected gift in that their satellite is broadcasting on 20 and 40 mc." Boulder Labs was one of the few labora-

AN ANNOUNCEMENT OF GREAT SIGNIFICANCE

**NEW
IMP**



Surface shape and base materials are no longer limiting factors for printed circuits.

Techniques developed by Motson Co. make possible the printing of electronic circuits on a wide variety of materials. These include plastics such as Teflon, isocyanates, epoxies, melamines, phenolics, acrylics, styrenes, polyesters, vinyls and other plastics . . . as well as other base materials such as mica, ceramics, paper and wood.

In addition to printing on flat surfaces, Motson circuitry is applied to curved surfaces.

CIRCLE 6 ON READER-SERVICE CARD

MOTSON DIRECT-PRINTED CIRCUITS

geometrical shape: curves, cones, spheres and tubes. If required, circuits can be a combination of printed on both sides of the base material. For example, having an inside diameter as small as one-half inch can be printed on both inside and outside surfaces.

The base material need not be rigid. Applications requiring a flexibility may use a thin, flexible material for the printing base.

The essential ingredients of direct-printed circuitry are conductive inks—an exclusive Motson development. There are three basic types of Motson silver inks modified with various additives for special

requirements. Heat stability varies from 180° to 500° F. One type may be dip- or iron-soldered. All types may be copper-plated to increase current-carrying capacity. Motson printed circuits are cleanly punched.

The thickness of ink deposits is, in general, between 0.0002 and 0.0018 inches and may be held within $\pm 10\%$ thickness. Pattern tolerance can be held to within ± 0.001 inches.

Motson Direct-Printed Circuits are used on rotors, stators, commutators, wave guides, capacitors, resistance heaters and antennae in devices used with computers, radar, guided missiles, aircraft, etc. While

Motson circuits are a relatively new development, performance is proved by satisfactory results from both exhaustive field tests and in-use service in a wide range of applications.

Motson Direct-Printed Circuits differ radically from circuits printed on copper-clad material. The conductive material is applied by printing where needed. No acid bath treatment is necessary. Motson circuits are not, generally, a substitute for copper-clad circuitry, but are an invaluable addition to the art. In some cases they make possible performance standards not heretofore obtainable, or economies of substantial magnitude.

WHERE, IN YOUR PRODUCTS OR PRODUCT DEVELOPMENT, CAN THE APPLICATION OF MOTSON DIRECT-PRINTED CIRCUITS MAKE A WORTHWHILE CONTRIBUTION?

Write us about a specific project; send any prints available and complete information. Motson engineers will provide, without obligation, an objective evaluation of the application of Motson Direct-Printed Circuits. J. Frank Motson Company, Flourtown, Pennsylvania. Telephone: (Philadelphia Exchange) CHestnut Hill 7-1900.



MOTSON

DIRECT-PRINTED CIRCUITS

CONDUCTIVE AND RESISTIVE

CIRCLE 6 ON READER-SERVICE CARD

atories in the U.S. properly instrumented to study radio waves coming from the outer atmosphere at these frequencies.

By studying the signals from the satellite, they expect to gain much knowledge about the amount of ionization the satellite is passing through and other characteristics of this ion media which are all important in radio transmission.



A continuous water washing system which is used to remove surface contamination from semiconductor components.

Cleaning Semiconductors

A highly effective continuous water washing system for removing surface contamination from semiconductor components has been adapted from tube techniques by Bell Telephone Laboratories, 463 West St., New York City. The system completely removes all the water-soluble materials which remain after etching, and monitors the effectiveness of the washing procedure.

When used on transistors, this system has resulted in significant improvements in breakdown voltage, "sharpness" of voltage-current characteristics, saturation current, and emitter reverse impedance. Thus it will contribute appreciably to the fabrication of semiconductor components having greater reliability and better operating characteristics, and will reduce the number of rejects.

Distilled water, replaced about once a week, is continuously recirculated through the system at about two liters per minute. It first passes through a small deionizing column which reduces its conductivity to about 0.1 micromho per cm as measured in a conductivity cell. The deionized water then rises through a vertical standpipe in which the parts being cleaned are suspended on a stainless steel frame. After flowing over the upper edge of the standpipe, the water passes through a second conductivity cell and thence to a sump for recirculation.



Focal point for the requirements of a growing industry

Today great companies in an ever-widening circle depend on Raytheon to supply magnetrons and klystrons for their microwave equipments.

By joining this distinguished roster you can be sure of tubes made to the highest standards of engineering craftsmanship—the ultimate in rugged duty,

first-rate performance and long, dependable life.

Comprehensive data booklets on Raytheon magnetrons, klystrons and special tubes are available on request. Our free Application Engineer Service is at your disposal. There is no obligation. Write for complete details.

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-26, Waltham 54, Mass.



Regional Sales Offices: 9501 W. Grand Avenue, Franklin Park, Illinois • 5236 Santa Monica Blvd., Los Angeles 29, California

Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Miniature and Sub-Miniature Tubes, Semiconductor Products, Ceramics and Ceramic Assemblies

Engineering Review

Miniaturization Award

In recognition of the growing concern with the problems of miniaturization (see *ED*, July 1, 1957, Micro Miniaturization Issue) an award has been established to stimulate further activity within industry toward the advancement of the concept of miniaturization. Sponsored by Miniature Precision Bearings, Inc., Keene, N. H., the award, a sculpture symbolizing miniaturization, is being administered by an independent committee of miniaturization experts.

Entries are being accepted and will be judged on ingenuity in solving problems and extending the frontiers in products, education, research, engineering, and standardization.

The award is to be presented in March 1958.

Inhabited Vacuum Lab

An Inhabited High Vacuum Laboratory which simulates the pressure conditions that prevail 95 miles above the earth is an invaluable research tool at the Air Force Office of Scientific Research. Designed by Litton Industries, Beverly Hills, Calif., the laboratory performs fundamental studies needed for the development of ultra-high-altitude weapons systems.

The new facility consists of a chamber, eight feet in diameter by fifteen feet long, and a pressure suit which permits researchers to observe and control experiments inside the vacuum chamber. Two pumping systems remove the air from the chamber, leaving only one out of every 18,000,000 molecules of air within the steel cylinder. A vacuum the equivalent of 528,000 feet above the earth is simulated. Protected by the unique pressure suit with its external system of oxygen supply and heat removal, an operator can inhabit this vacuum and perform intricate research duties.

The laboratory will be used to facilitate the advancement of knowledge about the behavior of physical phenomena, equipment, and instrumenta-

◀ CIRCLE 7 ON READER-SERVICE CARD
CIRCLE 8 ON READER-SERVICE CARD ▶

NOV 19 1957

CALIBRATED MICROWAVE FIELD INTENSITY RECEIVER SYSTEM

*absolute measurements—
radiation, interference and leakage
1,000 to 10,000 mc*

The new Polarad Model FIM is the only instrument approved Class A MIL SPEC. MIL-I-006181C for performing radiation leakage measurements in the range 1,000 to 10,000 mc. It is a complete system including a monitor unit, 4 interchangeable tuning units covering the range 1,000 to 10,000 mc, a separate power supply, a series of antennas to match the frequency range of each tuning unit and one broadband omnidirectional antenna. The monitor unit provides meter, video, audio and recorder outputs. The power supply provides regulation of plate and filament voltages



FIELD INTENSITY MEASUREMENTS

Absolute measurements of field intensity are possible with the Model FIM field intensity receiver system. An incoming signal, received by the calibrated antenna, is matched against the signal of an internal calibration signal source to determine absolute power. The instrument is completely shielded to prevent stray signal pickup.



Over the frequency range 1000 to 10,000 mc, interference radiated from any electronic equipment can be determined and examined to meet the requirements of commercial or military specifications.

—Direct indication by peak reading slide-back V.T.V.M. and by quasi-peak meter function.

—Average indication of unmodulated carrier; average or peak indication of modulated carrier.



CONDUCTED INTERFERENCE MEASUREMENT

The Model FIM receiver system can be used to determine radio interference voltages operating on external power conductors, or other external system connections, by connecting the monitor unit to a line stabilization network. Both broadband and CW interference signal levels may be measured as described in "Radiated Interference Measurements" (above).



Because of the sensitivity of the FIM receiver system, transmitter and receiver antennas can be separated by distances great enough to avoid phase errors. Minor lobes can be carefully investigated. The automatic frequency control allows the use of a relatively unstable signal source. Preselection eliminates errors that may be caused by the presence of harmonics of the signal or spurious signals.



SENSITIVE R-F VOLTMETER AND POWER METER

The Model FIM receiver system will measure carrier levels from 10 micro-microwatts to 2 watts. A multi-position coaxial step attenuator is provided to switch ranges quickly, and the effective noise bandwidth is constant for the full r-f range of the instrument. UNI-DIAL single knob tuning permits quick frequency scanning.

POLARAD IN ACTION
PROVEN RELIABILITY



MODEL FIM SYSTEM

BASIC MONITOR UNIT—FIM-B

POWER UNIT—FIM-P

TUNING UNITS (interchangeable)

*FIM-L 1,000 to 2,240 mc

*FIM-S 2,140 to 4,340 mc

*FIM-M 4,200 to 7,740 mc

*FIM-X 7,360 to 10,000 mc

*U. S. PATENT NO. 2,774,243

Contact Polarad or your nearest Polarad representative for complete details.

**POLARAD ELECTRONICS
CORPORATION**

43-20 34th Street, Long Island City 1, N. Y.

REPRESENTATIVES: Abington, Albany, Atlanta, Baltimore, Boeing Field, Chicago, Cleveland, Dayton, Denver, Detroit, Englewood, Fort Worth, Kansas City, Los Angeles, Orlando, Portland, Rochester, St. Louis, Stamford, Sunnyvale, Syracuse, Washington, D.C., Westbury, Westwood, Wichita, Winston-Salem. Canada: Amprior, Ontario, Resident Representatives in Principal Foreign Cities.

ULTRA-BROADBAND

MICROWAVE SIGNAL GENERATOR



MSG-34

one continuous
control frequency

4,200 - 11,000 mc

*Replaces 2 or more present day
signal generators normally required
to cover C and X bands*

The new Polarad MSG-34 outperforms all existing signal generators both in frequency coverage and ease of operation. In all respects, it is the most efficient and economical instrument to generate frequencies between 4,200 and 11,000 mc at a high power level.

By means of a unique design utilizing Polarad's exclusive UNI-DIAL control, Ultra-Broadband Frequency Coverage has been achieved in one completely integrated unit. Attenuator index is automatically set throughout the entire band after calibration, thus avoiding possible error when making accurate measurements rapidly. Frequency is read directly from a 4 foot linear dial that is easy to read.

Some unusual features:

Calibrated output: 1 milliwatt

Internal pulse modulations

.2 to 10 u sec. pulse width

10 to 10,000 prf

2 to 2,000 u sec. delay

Pulse rise and decay time 0.1 u sec.

Attenuator index independent of power set

Long life non-contacting choke in oscillator

Provision for external modulation, sine wave, pulse or multiple pulse.



SPECIFICATIONS:

Frequency Range:
4,200 mc to 11,000 mc

Frequency Accuracy: $\pm 1\%$

Power Output:
1 milliwatt (0 dbm)
calibrated

Attenuator Output Range:
0 dbm to -127 dbm,
0.223 volts to 0.1
microvolt,
(directly calibrated).

**Attenuator Output
Accuracy:** ± 2 db from
0 to -127 dbm

Output Impedance:
50 ohms nominal.

Output VSWR: 2:1 maximum

Internal Pulse Modulation:
Width: 0.2 to 10 micro-
seconds.

Repetition Rate: 10 to
10,000 pps

Delay: 2 to 2,000 micro-
seconds.

Sync: internal, external-
pulse or sine wave.

Rise Time: 0.1 microsecond
as measured between
10% and 90% of maxi-
mum amplitude of the
initial rise.

Decay Time: 0.1 micro-
second as measured be-
tween 10% and 90% of
maximum amplitude of
the final decay.

Internal Square Wave:
Rate: 10 to 10,000 pps.
Symmetry: $\pm 5\%$
Sync: Internal

Internal FM:
Type: Linear sawtooth.
Frequency Deviation:
5 mc minimum.
Rate: 10 to 10,000 cps.
Synchronization: Internal
or external, pulse or
sine wave.

External Pulse Modulation:
Polarity: Positive or
negative.
Rate: 10 to 10,000 pps.
Pulse Width: 0.2 to 100
microseconds.
Amplitude: 10 to 40 volts
peak.

**Output Synchronization
Pulses:**
Polarity: Positive, delayed
and undelayed
Rate: 10 to 10,000 pps.
Amplitude: 15 volts peak
minimum.
Rise Time: Less than 0.25
microsecond.

External Sync:
Type of Input: Positive,
negative, or sine wave.
Amplitude: Pulse: 5 to 50
volts peak;
Sine wave: 5 to 40 volts
rms.

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.

REPRESENTATIVES: Abington, Albany, Atlanta, Baltimore, Boeing Field, Chicago, Cleveland, Dayton, Denver, Detroit, Englewood, Fort Worth, Kansas City, Los Angeles, Portland, Rochester, St. Louis, Stamford, Sunnyside, Syracuse, Washington, D. C., Westbury, Westwood, Wichita, Winston-Salem, Canada: Arnprior, Ontario. Resident Representatives in Principal Foreign Cities.

under conditions of extremely low pressure and density. Such knowledge is prerequisite to the development of high-altitude weapons systems.

Powerful Office Machine

The new IBM 705-III for business data processing has a completely transistorized magnetic tape unit with an input-output rate fast enough to read or write the equivalent of a full-length novel once every fifteen seconds. Business information can be read or written at the rate of 60,000 characters per sec, automatically checking the information for validity and readability at the same time. Tape density has been increased, enabling each tape reel to store up to three times more information.

A new data synchronizer incorporated in the system controls magnetic tape input and output so problem data may be read, computations made and answers written simultaneously.

A 40,000 bit magnetic core memory is provided. The high speed memory can be enlarged to 80,000 bits by the addition of another core storage unit. The increased capacity enables the system to process many applications directly in core memory without resorting to other storage means.

Give Away Components

Trying to do its share to relieve the shortage of engineering and technical personnel, Westlab Electronics, Inc., Yonkers, N.Y. is encouraging youngsters to enter these fields by giving them electronic components free. Each week Westlab makes available thousands of dollars worth of surplus tubes, condensers, resistors, and other components to the High School youths of Westchester county. The corporation, which designs and installs sound and intercommunications systems, intends to have open house each Thursday for the rest of the year. In January, Westlab will award a High Fidelity amplifier to the student making the most novel use of the parts.

◀ CIRCLE 8 ON READER-SERVICE CARD

CIRCLE 9 ON READER-SERVICE CARD ▶



Can a 30% increase in magnet energy simplify your design problem?

It probably can if you're faced with the tight space problems involved in today's control and navigation instrumentation, communication, auxiliary power and radar equipment designs.

Only Crucible investment-cast Alnico permanent magnets offer the higher energy you need — 30% more than sintered magnets, for example, size for size. Crucible increases the energy product even further by adding fractional

amounts of silicon and zirconium to the magnet composition. These additions also help provide a fine surface finish that is free of gas pockets and other discontinuities. This uniform surface makes grinding easier and faster.

Why not take advantage of Crucible's facilities and experience in this specialized field? A Crucible magnet engineer can work on your problem now. Just call the Crucible office nearest you.

Crucible, the only producer of higher energy investment-cast Alnico permanent magnets, also offers you sand-cast and shell-molded magnets in any shape, tolerance and finish needed. Sizes range from a fraction of an ounce to several hundred pounds.

General Sales Offices, The Oliver Building, Mellon Square, Pittsburgh 22, Pa. Branch Offices and Warehouses: Atlanta • Baltimore • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Denver • Detroit • Grand Rapids • Harrison • Houston • Indianapolis • Los Angeles • Milwaukee • New Haven • New York • Philadelphia • Pittsburgh • Portland, Ore. • Providence • Rockford • San Francisco • Seattle • Springfield, Mass. • St. Louis • St. Paul • Syracuse • Toronto, Ont.

CRUCIBLE

first name in special purpose steels

Crucible Steel Company of America

MB FACTS













TINY SIZE...

TREMENDOUS IMPORTANCE!

New Departure has many years of experience in the manufacture of ball bearings to the finest ultra-precision tolerances. And . . . New Departure uses the most advanced equipment for research, development and production in making a

full range of bearings of precision instrument classification. A new catalog, including miniature sizes, plus additional information helpful to you in design problems sent on request. Write New Departure, Division of General Motors, Bristol, Conn.

ASK FOR CATALOG P.I.B.

FULL SIZE	BORE B		DIAMETER D		WIDTH W		BALLS		CORNER RADIUS r (To Clear)
	FRAC- TION	DEC- IMAL	FRAC- TION	DEC- IMAL	FRAC- TION	DEC- IMAL	NO.	DIAM- ETER	
	3/64	.0469	3/32	.1562	1/16	.0625	5	1/32	.005
		.0550	3/16	.1875	3/64	.0781	6	1 mm	.005
	3/64					.0937	5	1/16	.006
	3/32					.125	8	.025	.005
	3/32						6	1/16	
	1/8							1 mm	
	1/8								
	3/32	.15							
	3/16	.1875							.005
	3/16	.1875	3/8					1 mm	.006
	1/4	.2500	3/8	.3750					.006
	1/4	.2500	1/2	.5000	1/8	.1250	*12	*1 mm	.006



NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

CIRCLE 10 ON READER-SERVICE CARD

Engineering Review

Radiophone Connects to Dial Exchange

A pushbutton-dialing radio telephone system has been developed by Motorola Inc., Chicago, Ill. to enable telephone companies with automatic telephone exchanges to provide radiotelephone service to both home and mobile radio users in sparsely populated areas.

Under test were an automatic base station, a fixed station installed in the home of a rural subscriber, and mobile units installed in a car and a truck.

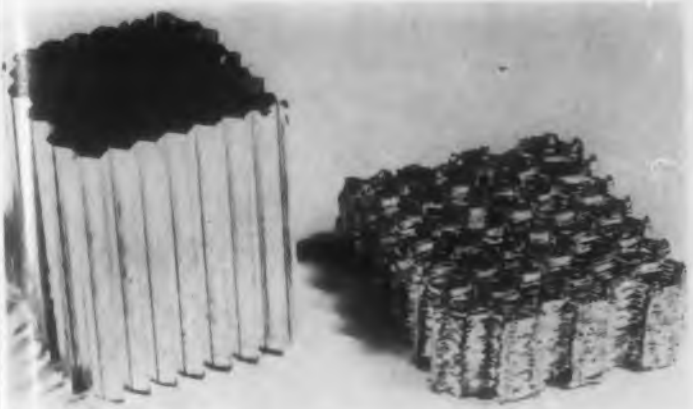
By utilizing radio rather than wire lines, the system eliminates the oftentimes prohibitive cost of installing and maintaining telephone lines to serve only a few widely separated homes. With this system, the telephone company's automatic base station, which receives calls from subscribers, connects directly with the unattended exchange via one of the regular 10-party subscriber line circuits. Specific tone sequences for dialing are utilized to prevent wrong numbers caused by radio interference.

Thin Screen X-Ray Amplifier

An experimental model of a thin screen amplifier for x-ray viewing was demonstrated recently by Radio Corporation of America's Princeton, New Jersey research center. The device increases the brightness of images in certain types of medical x-ray examinations one hundredfold.

The device consists basically of a thin "sandwich" of two special materials in adjoining layers between transparent electrodes. One of the layers consists of photoconductive powder which conducts current when exposed to x-ray or light radiation. The other layer is an electroluminescent phosphor which emits a bright light when an electric current is passed through it. A voltage is applied across the "sandwich" structure. When an x-ray pattern strikes the photoconductive layer, current passes through to the electroluminescent layer, which emits light corresponding to the x-ray pattern.

The amplifying panel is comparable in size and thickness to present conventional x-ray fluoroscope screens. It provides a stationary display of an image, 100 times brighter, and with greater contrast than those on conventional screens. The bright image can be retained for up to 30 sec after a short exposure. The screen can be cleared instantly by a new electronic erasing technique.



The **accordion type** collapse of honeycomb core is illustrated in these before and after views of core samples. The accordion folds in the cells occur progressively starting at one face as the core collapses at a constant rate during impact.

Honeycomb As Impact Absorber

Aluminum honeycomb cores form an almost ideal material for impact energy absorption, according to research results made public by Hexcel Products Inc., Oakland, California. Extensive tests have established that this core collapses under impact loads in an accordion fashion and absorbs impact energy at a nearly constant rate. This characteristic makes the honeycomb structure an almost ideal material for reducing damage due to impact forces. When an automobile hits a telephone pole, or a crate falls off the end of a truck, the amount of damage sustained is a direct function of the deceleration rate. If the deceleration occurs virtually instantaneously, all of the kinetic energy of the moving body is likely to be converted into destructive action. On the other hand if the deceleration takes place over even a brief period of time, allowing the mass of the moving body to slow to a stop, the destructive impact forces, or g-loads are reduced to a fraction. Most padding materials deform in a non-linear fashion; the more the deformation, the higher the resistance to further deformation. An "ideal" shock absorber, on the other hand, presents a constant resistance, or force, during its total deformation. In this way, the deceleration force can be held at a constant g-load just below the damage level. The constant resistance to deformation demonstrated by honeycomb comes much closer to duplicating the characteristics of an ideal shock absorber. Hexcel has found that by densifying the honeycomb core cells with a foamed plastic, they can increase the stress-to strain ratio and still retain a flat curve response on a deformation curve. In this way the linear deformation characteristics of the honeycomb core material can be applied to cases where higher g loads can be tolerated. For example, aluminum with one-eighth inch cells made up of .0015 inch wall thickness, has a crushing strength of approximately 350 psi. Filled with plastic foam, the crushing strength of the honeycomb core is increased to about 2500 psi.



this is the business end of a Kahle glass diode beading machine producing 12,000 beaded leads in a single 8-hour day at lower cost than ever before.

AUTOMATE? - CONSULT THE PIONEER MANUFACTURER OF AUTOMATIC SEMICONDUCTOR MACHINERY.

FOR 25 YEARS, KAHLE HAS DESIGNED AND CONSTRUCTED AUTOMATIC MACHINERY FOR ELECTRONIC TUBE PRODUCTION.

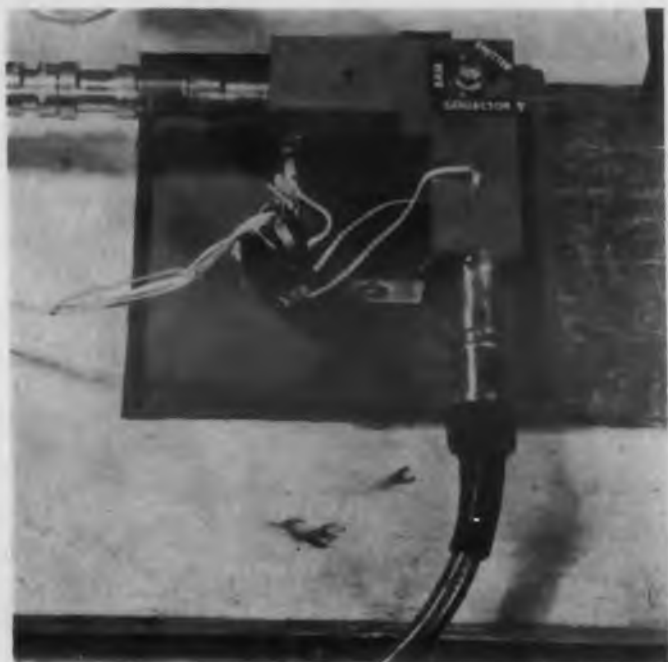
KAHLE CAN HELP YOU WITH ANY PHASE OF SEMICONDUCTOR PRODUCTION. SEND US YOUR SPECIFIC REQUIREMENTS.

KAHLE
ENGINEERING COMPANY

GENERAL OFFICES: 1310 SEVENTH STREET, NORTH BERGEN, N. J.
PLANTS: SEVENTH STREET, NORTH BERGEN, N. J.
HUDSON AVE., UNION CITY, N. J.

DESIGNERS AND BUILDERS OF SPECIAL AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL OPERATIONS

CIRCLE 11 ON READER-SERVICE CARD



Coaxial jig which is used for determining hybrid transistor characteristics.

Transistor VHF Characteristics

A technique for accurately determining transistor characteristics in the grounded emitter configuration at 30 to 300 mc has been developed by R. P. Abraham and R. J. Kirkpatrick of Bell Telephone Laboratories, 463 West Street, New York 14, N.Y. Precise measurements of transistor characteristics in the VHF range are necessary due to the increasing use and potential applications of transistors at frequencies up to 300 mc. Four measurements and subsequent calculations are made which yield the four complex hybrid parameters, and from these the validity as well as the element values of any equivalent circuit may be determined. The calculations needed to transform the measured data to the hybrid parameters are programmed on a digital computer. Measurements are made with the aid of a suitable rf signal source and a Rhode-Schwarz Diagraph, used in conjunction with specially designed coaxial jigs. Reduction of the measured data to the desired parameters involves calculations which take into consideration three factors: the effects of shunt and series parasitics, imperfect terminations, and the effects of common impedances. The digital computer which makes the necessary computations is programmed to take these factors into consideration.

Forget leads, insert Wejcap capacitors, see costs of print board assemblies drop



Lead Metaniobate

A piezoelectric material recently developed by General Electric, Lead Metaniobate remains remarkably stable over the temperature range from -54°C to 265°C , an important fact in high-temperature instrumentation devices. It displays superior aging characteristics compared with other ceramic piezoelectric bodies. The high Curie temperature (570°C) allows repeated heat cycling with no effect on electrical output.



Encapsulated RC Networks

A new series of encapsulated RC networks is now available from General Electric that replaces a host of individual resistors and capacitors. The price saving can be ten percent or better. The assembly saving in print wire boards—inserting one unit instead of five or ten—averages about 67 percent. Furthermore, this small RC network results in a smaller overall assembly, cutting board costs.

CIRCLE 12 ON READER SERVICE CARD

New stabilized types or general purpose types cost up to 35% less, resist breakage and moisture.

Wejcap capacitors were specially developed to let you realize more fully the economy and design advantages of printed boards. They are a product of General Electric research into the high density, high strength properties of improved barium titanate. They have no leads to bend or break, or that require extra time to crimp and align. Extensive production use proves Wejcap capacitors are practically unbreakable and resist moisture absorption. They are available in general purpose types, or in the new stabilized types that maintain their value at room temperature to within $\pm 20\%$ of the nominal value.

How much can you save? Wejcap capacitors cost up to 35% less than other capacitors. Production runs show that four Wejcap capacitors can be inserted in the time it takes to put in three ordinary capacitors. The total cost and assembly savings will be appreciable, even if you apply only three Wejcap capacitors to your production chassis.



Thru-Con* print wire boards. Now you can design a compact wiring pattern on both sides of the board without the cost of further processing to connect them. The "Thru-Con®" additive technique plates through the holes at the same time it plates the wiring pattern. This permits

high-speed dip soldering remarkably free from rejects. No special eyelets or pre-cleaning are required. Assembly weight is reduced and inventory is simplified.

Sample Wejcap capacitors and other General Electric components—plus technical data—are yours for the asking. Just fill in the coupon below. *Specialty Electronic Components Dept., General Electric Company, West Genesee Street, Auburn, New York.*

*Registered trademark of the General Electric Company.

Manager of Sales, Specialty Electronic Components Dept., 11157
General Electric Company, West Genesee St., Auburn, New York

Please send me complete technical information on

RC Networks Lead Metaniobate
 Ferrites Wejcap Capacitors
 Thru-Con® Print Wire Boards

Name _____ Position _____
Company _____
Address _____
City _____ Zone _____ State _____

E1157

CIRCLE 12 ON READER-SERVICE CARD

Automation—Uniformity, Reliability

At the Fall Meeting of The American Society of Mechanical Engineers, Mr. M. V. Hayes of the Jones and Lamson Machine Co., Springfield, Vermont raised some disturbing points about the state of the art of automation. One of the major problems, he pointed out, is machine maintenance. Fully automatic machines, he felt should be able to run for 20 years without failure. As things stand today, one might find one of his automatic machines has destroyed itself.

Mr. Hayes also suggested that electrical input signals from tape readers should be uniform so that all machines could be wired to a central control room. This would allow a machine to receive commands from a central location in standardized form.

Integrated Missile System

The Matador is the first completely integrated missile system developed under the Air Force Weapons System approach. With this approach, a company is made responsible for developing not just a plane or missile, but everything that goes with it, right down to determining the skill level needed by the airmen who will use it.

The Matador, developed by The Martin Co., Baltimore, Maryland, contains not only a missile, but a launcher, a prime mover, test equipment, and ground handling equipment. Redesignated TM-76 instead of TM-61B, it is scheduled for production in early 1958 while developmental missiles are being tested at Holloman Air Force Base in New Mexico. During the tests the entire system is checked out. New automatic testers are used under field conditions while field maintenance and support procedures are developed.

The TM-76 is a ground-to-ground, jet powered tactical missile capable of carrying conventional or atomic warheads. It can fly faster than 650 mph. Longer than its predecessors at 44 ft, it has a shorter wing span of 22.9 ft.

Among the new features is a guidance control range which has been extended considerably. Two interchangeable guidance systems are used. One permits low level attack while the other gives an altitude capability of over 40,000 ft. With either system, it is almost impossible for enemy radar to "jam" the guidance system.

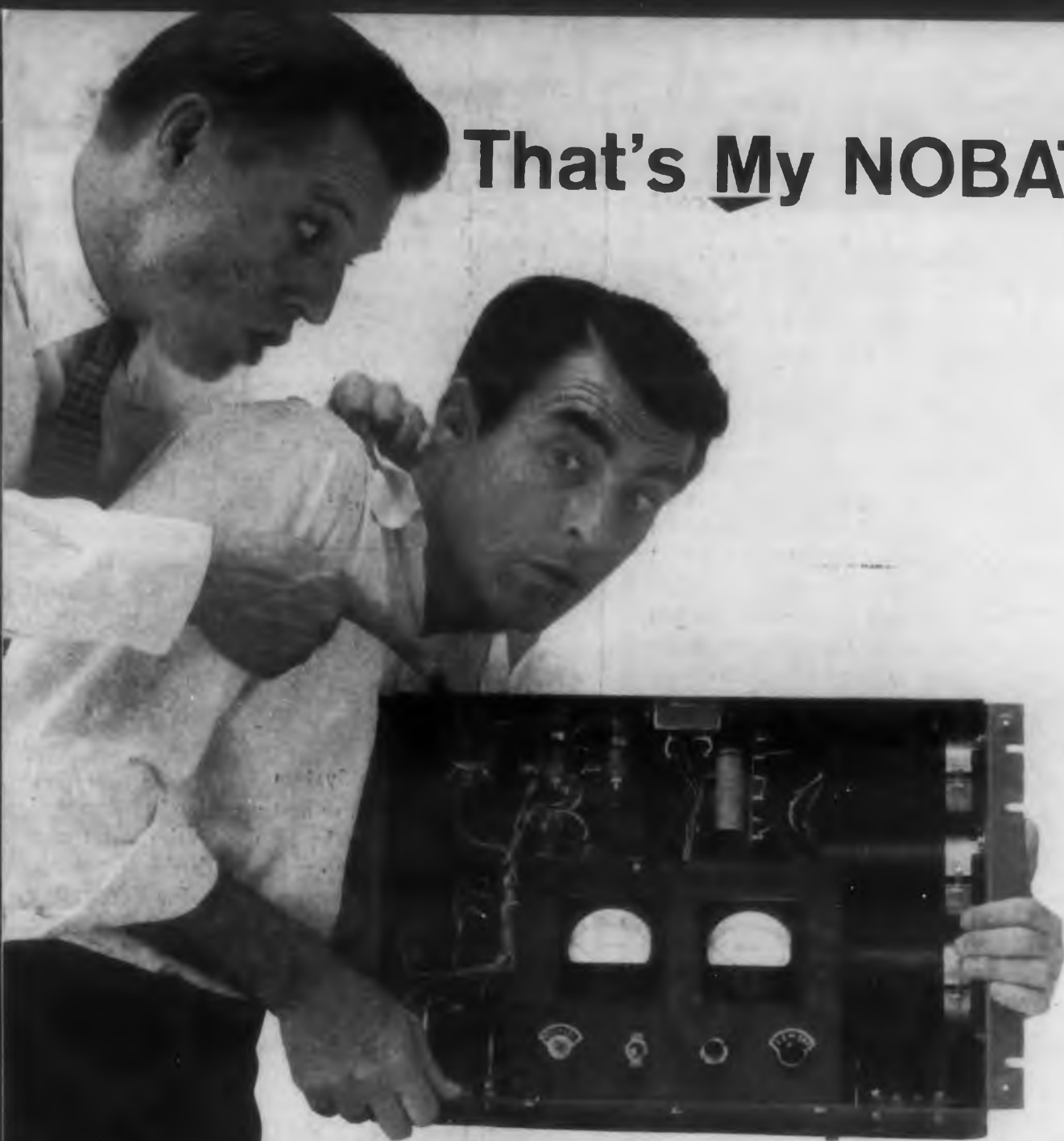
The Matador employs a special prime mover and launcher to provide greater maneuverability and adaptability to rugged terrain.

Automatic test equipment, part of the Matador system, will lower the skill level required by the airmen who operate the system.

Progress Is Our Most Important Product
GENERAL ELECTRIC

works
ic that
rs and
be ten
ing in
nit in-
7 per-
etwork
y, cut-

That's My NOBATRON®!



Regulated DC Sources for Low-Voltage High-Current— 6, 12, 28, 48, 125, 200 Volts at 5 to 75 Amps.

For a reliable *sustained* low-voltage DC supply, delivering the power that covers most laboratory and many industrial applications, and with voltage variation held within $\pm 0.2\%$... these Nobatrons just can't be matched—by anything, anywhere.

Nobatrons are in use, by the thousands, all over the world. Many of them have been in operation continuously over a span of years. Conservative design and generous specifications insure long life—especially for wound components.

So effective is the Sorensen regulating principle in correcting line and load drops that output has the stability of a battery supply over extended periods. And the

disadvantages of batteries—recharging, acid handling, fixed voltage, temperature problems—are eliminated.

Over-voltage protection is assured by a special safety diode that impels a voltage drop in case of filament failure, with other protective devices safe-guarding all components against power surge.

Most units are designed for rack-mounting, and with cabinets for bench use.

Let your local Sorensen representative give you complete data on these Sorensen DC Nobatrons or write directly for specific information. Please address **SORENSEN & COMPANY, Inc.**, Richards Avenue, South Norwalk, Connecticut.

TYPICAL SPECIFICATIONS Model E-28-5* (illustrated)

Output Voltage	28 VDC, Adjustable $\pm 10\%$ with rated accuracy	Load Range	0.5 to 5 Amps at Rated Accuracy; accuracy decreases to around $\pm 0.5\%$ for no load.
Input Voltage	95-130 VAC, single phase, 50/60 cycles.	Ripple Voltage	1% RMS at 60 cycles. Filters available to reduce ripple to 0.1%
Regulation Accuracy	$\pm 0.2\%$ against line from 105 to 125 VAC Input; $\pm 0.2\%$ against load.	Time Constant	0.2 second
		Size	Rack height 12 $\frac{1}{4}$ " Cabinet Size 21 $\frac{3}{4}$ " x 14" x 15"

*Write for data on other models and capacities.



CONTROLLED POWER FOR
RESEARCH AND INDUSTRY

Engineering Review

Computer to Measure IQ

New research in the measurement of man's intelligence is the first job given to an electronic computer recently completed by the National Cash Register Company, Hawthorne, Calif. The computer, complete with an auxiliary tape memory unit and input-output equipment, is installed in special new facilities in the University of Southern California Engineering Building, Los Angeles, Calif.

The computer may help to lead the way to a comprehensive theory on the intellectual processes of man, with special emphasis on creativity. Based on approximately 45 established factors of intellect, the computer provides a "many-sided" picture of intelligence and eliminates the old single score test. One of the implications of the new system is that there may be as many as 75 intellectual factors in which individuals may differ.

The NCR electronic computer system, by reducing the time needed to analyze test scores, will make it possible to obtain quick test results, even from large groups of people.

As data from many tests are fed into the computer, correlated results emerge immediately on punched paper tape. The tape in turn operates an automatic typewriter which rapidly prints the results in tabular form.

Teletypewriter Links U. S. and Brazil

International teletypewriter exchange service (TEX) between the United States and Brazil has been made available by RCA Communications, Inc., New York, N.Y. The new service enables businessmen and government departments in the two countries to engage in direct, two-way radio-teletypewriter communication. The circuit was dedicated at ceremonies held simultaneously in Rio de Janeiro and Washington, D.C. Ernani Do Amaral Peixoto, Brazilian

◀ CIRCLE 13 ON READER-SERVICE CARD

ambassador to the United States, exchanged greetings during the first FAX call with Brazilian Secretary of State Jose Carlos De Macedo Soares in Rio. Their message lauded the importance of the service to commercial and government communications.

Universal Standards Committee

Inter-American standards for manufactured products and raw materials will be established, according to a resolution by the Inter-American Meeting of Experts on Standardization. These standards will be basic to science and engineering, indispensable to industry and a vital factor in promoting commerce and trade. The committee urged the establishment of a national standards body in every country that does not have one. The committee took the first step toward the development of standards bodies where they are not in operation by stating the broad, fundamental principles underlying the formation of these bodies. These principles can be adapted to meet the particular conditions in the individual countries.

The only effective standards are those which are mutually acceptable to all parties affected by them, and while it recognized that government participation in standards work is highly desirable, the group contends that these standards must be developed under the guidance of an organization which brings together the producer or manufacturer, consumer or user, the technical expert and the government. Such an organization would be much like the American Standards Association in the United States.

The committee also outlined the basic principles for setting up standards laboratories. Planned standards institutes would be completely ineffective without the support of standards laboratories to determine whether raw materials or manufactured items comply with the standards under which they are bought and sold.

CIRCLE 14 ON READER-SERVICE CARD ➤

Introducing... the world's most compact radiation- cooled high-power INDUSTRIAL TRIODE

...the new

Amperex® 7092



(Approx. 3/4 actual size)

2 KW CONTINUOUS, 3 KW INTERMITTENT

INTO INDUSTRIAL LOADS - CLASS C - WITHOUT WATER COOLING

INDUSTRIAL OSCILLATOR, CLASS C CONTINUOUS DUTY SINGLE PHASE, RECTIFIED, UNFILTERED PLATE SUPPLY

Typical Operation (Per Tube)

Frequency	50	50	50	Mc
D.C. Plate Voltage	2700	3600	4500	Volts
D.C. Grid Voltage	-270	-325	-360	Volts
Peak R.F. Grid Voltage	625	685	720	Volts
D.C. Plate Current (Full Load)	630	630	630	mA
D.C. Plate Current (No Load)	180	155	135	mA
D.C. Grid Current (Full Load)	180	160	145	mA
D.C. Grid Current (No Load)	305	270	250	mA
Grid Resistor	1500	2000	2500	Ohms
Driving Power (Approx.)	125	123	115	Watts
Plate Load Impedance	2250	3000	3800	Ohms
Plate Dissipation*	540	640	780	Watts
Plate Input	2100	2800	3500	Watts
Tube Plate Output	1560	2160	2720	Watts
Tube Efficiency	74	77	78	Percent

*For 50% duty cycle, averaging time 10 seconds, plate dissipation may be increased 50%.

- extra-thick hard-glass envelope for exceptional ruggedness and temperature resistance
- thoroughly dependable service in ultrasonics, induction and dielectric heating at a 40% saving in tube and accessory costs
- thoriated-tungsten filament—6.3 volts, 32.5 amps
- available from stock



ask **Amperex**

...about new tubes for
high-power industrial applications

Further details available from Industrial Tube Division

AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, L.I., N.Y.

In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17.

Engineering Review

"Ten Electro-Commandments"

For the benefit of those who engage in electronics design, development, and just plain tinkering, take heed for disobeying may be high.

1. Beware the lightning that lurketh in an undischarged condenser lest it cause thee to bounce upon thy head in a most ungentlemanly manner.
2. Cause thou the switch that supplieth large quantities of juice to be opened and thusly tagged that thy days may be long in this earthly vale of tears.
3. Prove to thyself that all circuits that radiateth and upon which thou worketh are grounded and thusly tagged lest they lift thee to radio frequency potential and causeth thee to make like a radiator, also.
4. Tarry thou not amongst those fools who engage in intentional shocks for they are not long for this world.
5. Take care thou useth the proper method when thou taketh the measure of a high voltage circuit so that thou dost not incinerate both thee and thy test meter; for verily, though thou hast no plant account number and can be easily surveyed, the test meter doth have one and as a consequence bringeth much woe unto the supply officer.
6. Take care thou tampereth not with interlocks and safety devices for this incurth the wrath of the supervisor and bringeth the fury of the department head upon thy shoulders.
7. Work thee not on energized equipment for if thou dost so thy shopmates will surely be buying beers for thy widow and consoling her.
8. Verily, verily I say unto thee never service equipment alone for electrical cooking is sometimes a slothful process and thou might sizzle in thine own fat upon a hot circuit for hours on end before thy Maker sees fit to end thy misery and drag thee into His fold.
9. Trifle thee not with radioactive tubes and substances lest thou commence to glow in the dark like a lightning bug.
10. Commit thou to memory all the works of the prophets which are written down in the chapters of thy bible which is the Safety Manual, and which giveth out with the straight dope and consoleth thee when thou has suffered from thy superior.

Reprinted from Report, U.S. Naval Ordnance Laboratory, Silver Spring, Md.

Department Store Automation

The nation's first fully automated department store data-processing system has been put into operation at Burdine's in Miami, Florida. Al-

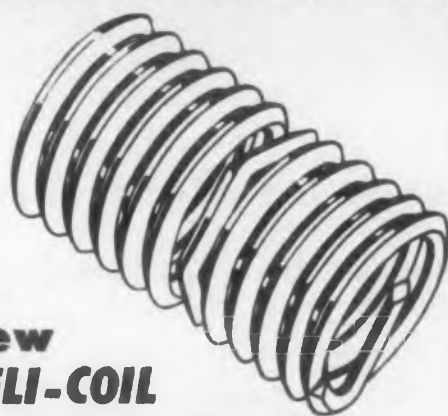


HELI-COIL Stainless Steel Screw-THREAD Insert

This is the insert that permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration and shock. Made of (18-8) stainless steel wire, cold-rolled into a diamond shaped cross-section, this *Heli-Coil* Insert is work hardened to a tensile strength of approximately 200,000 psi . . . conforms to military standards MS 122076 through 122275 (ASG) and MS 124651 through 124850 (ASG) . . . conforms to standard commercial and industrial thread forms, including coarse, fine, pipe-thread and MM sizes . . . permits use of standard boss configurations.



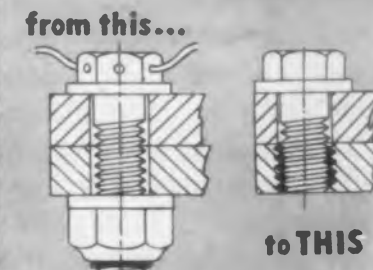
Save Space, Weight and Costs
Substantial savings in materials, weight, space and costs are possible, as against solid bushings, because smaller (or standard) bosses, flanges and threaded fasteners can be used



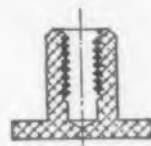
New HELI-COIL Stainless Steel Screw-LOCK Insert

Pat. Pending.

Conforming to military specifications for locking torque and vibration, this notable new *Heli-Coil* Screw-LOCK one-piece insert provides all the thread protection of the Screw-THREAD Insert, PLUS an exclusive internal locking feature that eliminates the need for clumsy protruding lock nuts, lock wiring and other supplementary locking devices . . . saves cost, space and weight . . . permits simplified streamlined design. The Insert is a permanently integrated part of the component—permits repeated service repair disassembly and reassembly, with locking action remaining unimpaired. Available in sizes from 4-40 up.



Internal Locking Feature
Insures positive internal locking action—eliminates lock nuts, lock wiring and other protruding locking devices—saves space, weight, cost. Yet screw may be easily disassembled with no loss of locking torque.



CUSTOM LOCK NUTS

The *Heli-Coil* Screw-LOCK Insert is adaptable to special-shaped lock nuts, shells, spacers and fasteners and can be engineered to meet your torque or performance requirements. *Heli-Coil Corporation* is fully equipped to manufacture these special lock nuts to your specifications.

Note: Custom nuts, with Screw-LOCK Inserts, meet military specifications for lock nuts.

➔ **Heli-Coil Field Engineers are at your service for**

Show Design Engineers the HELI-COIL* INSERTS to

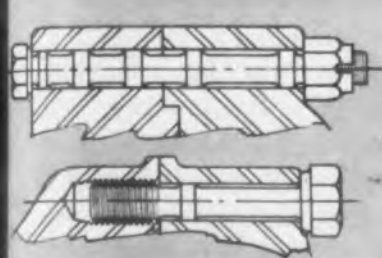
SAVE: SPACE—WEIGHT—COSTS

PERMANENTLY PROTECT THREADS AGAINST

ABUSE • WEAR • CORROSION • STRIPPING • GALLING • SEIZING • VIBRATION

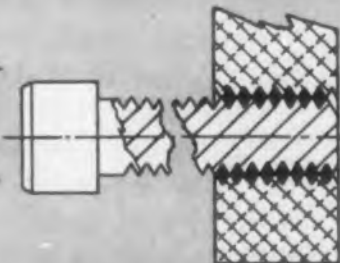
Eliminate Lock Nuts—Lock Wiring—Lock Washers

Some Typical Heli-Coil Screw-THREAD Applications



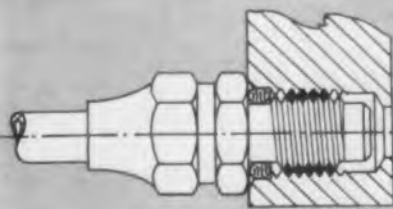
Compact Design

Improves design features by elimination of nuts, washers and extra-length bolts.



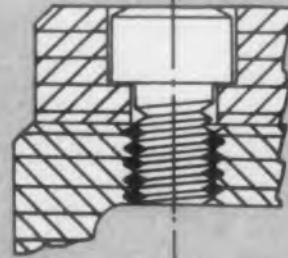
Stronger Thread Connections

Under excessive tension, torsion and impact loads in standard proportion bosses, the screw will break but the Heli-Coil Screw-THREAD Insert will remain undamaged... even in light alloy metal.



Leak-Proof Connections

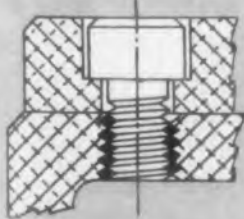
In lightweight, high pressure hydraulic equipment, stainless steel inserts, regular and pipe thread, protect threaded pump and valve ports sealed with "O" rings.



Steel Threads in Wood, Plastics and Fiberglass

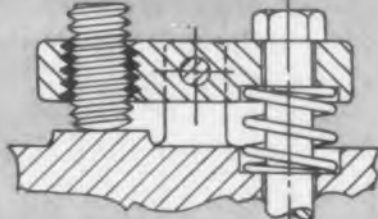
Provides permanent, strong, corrosion-resistant and wearproof threads in soft materials. Especially valuable where frequent assembly and disassembly is necessary.

Some Typical Heli-Coil Screw-LOCK Applications



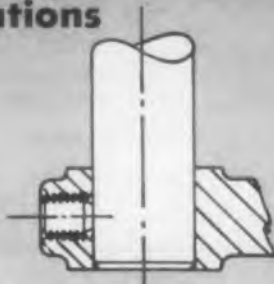
Flush Nut Assemblies

Permits a securely locked, flush assembly, because its internal locking feature eliminates need for drilled head bolts and other protruding locking devices.



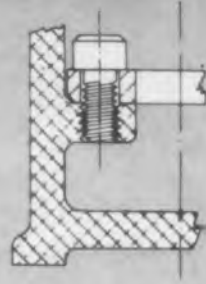
Lock Adjustment Screws

This simple design allows permanent, positive adjustment of screws in any position, secure against vibration or impact.



To Lock Set Screws

Positively locks assembly against loosening at desired adjustment—protects threads against stripping under high torque—permits use of light housing materials.



Inaccessible or Miniaturized Assemblies

Heli-Coil Screw-LOCK Insert permits installation of the locking feature from front or top. No blind fumbling for assembly of locking devices inside or behind.

design consultation—without obligation.

HELI-COIL CORPORATION



A Division of Topp Industries, Inc.

*Reg. U.S. Pat. Off.

HELI-COIL CORPORATION

411 Shelter Rock Lane, Danbury, Conn.

Gentlemen: Please send me further information on

- Heli-Coil Screw-THREAD Inserts.
- Heli-Coil Screw-LOCK Inserts.
- Heli-Coil Custom Lock Nuts.
- Have a Heli-Coil Thread Engineer call—without obligation.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

In Canada: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

CIRCLE 15 ON READER-SERVICE CARD

though in-store experimentation with electronic equipment has been carried on by many manufacturers for more than two years, Burdine's is the first to install a completely integrated store-wide system. With this type of system, it is possible to change clerks from pencil pushers to button punchers. The complete electronic system can record a customer's transaction in as little as 10 seconds and computes daily totals at the rate of 24,000 additions per minute. Brains of the system are 43 Clary Transactors and a Royal McBee LCP-30 computer. The transactors, automatically write the customer's sales checks, eliminating sales books and hand-written receipts. Simultaneously, they print by means of an electronic punch all sales information on common language tapes for processing through computers or cards. These tapes, when fed through the computer, provide the store with a complete picture of its daily business in from two to five hours, depending upon the day's volume. Thus, Burdine's can now gather electronically in a few hours vital sales information which it formerly took days and even weeks to compile. And customer service has been speeded appreciably.



Complete Environmental Simulator: This environmental chamber can simulate all the varying climatic conditions called for in government specs in addition to providing vibration tests under any specified climate. It was designed by Tenney Engineering, Inc., of Union, N. J. for Canadian Westinghouse Company's new half million dollar electronics plant at Hamilton, Ontario. Tagged the "Stratosphere", the chamber can provide temperatures from minus 100 to plus 200 F and can evacuate to 50,000 ft at an average climb rate of 5000 ft per min. Shown is a test missile being removed after undergoing complete environmental simulation.

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price \$340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price \$450.

*

The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.



PALO ALTO 21 CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

CIRCLE 16 ON READER-SERVICE CARD

Washington Report

Herbert H. Rosen

Ionospheric Scatter Review

A report has been made available giving the conclusions reached by a Consultants Conference on Ionospheric Scatter Communications. The conference was held last February, but the host organization, the Office of Defense Mobilization, has only recently released a summary of the findings. These are: (1) Continued vigorous study is needed of the quantitative aspects of interference potentialities, both through experiment and analysis; (2) Continued development effort is needed in the areas of improved antennas and modulation methods to ameliorate multipath difficulties, and on modulation techniques for voice transmissions; (3) To permit operation with greater channel capacity and at higher frequencies than at present, transmitters are needed of higher power than presently available.

These findings have come out of the practical experience of those intimately associated with scatter. Operational data from the Air Force's "White Alice" experiments probably formed a large part of this foundation. One thing became apparent: there is an increased awareness of the differences between the research aspects of scatter and operational circuit problems.

High reliability is the prime goal. But only through operations utilizing scatter at least part of the time can reliabilities approaching 100 per cent be achieved. This for radio communications in the 1000-2000 km distances. When the MUF (maximum useable frequencies) for the path is above the frequency being used, (by a fixed station, for example), the problems of long-range interference and interception are about equal to those of the usual high-powered fixed services. When the MUF is nearer the used frequency, special multipath effects appear which require special engineering to overcome.

When the MUF is well below the used frequency, interference and interception problems essentially disappear. However, high power transmitters and high receiver sensitivity are required.

Ionospheric scatter further has certain frequency limitations that hamper operations. At the lower edge (25 to 30 Mc), transmissions are vulnerable to absorption during ionospheric disturbances. Very strong power dependence characterizes the upper end of the spectrum. Thus a frequency increase of 20 Mc will require about 10 times as much power for a given bandwidth, or conversely, will provide about 1/10 the bandwidth for a given power.

Several methods for operating these circuits suggest themselves, according to the consultant. One is the use of a single fixed frequency. It would be selected on the basis that the MUF will not exceed it at any time during the sunspot cycle. However, high power would be required for a given bandwidth—both high maximum transmitter power which effects the equipment cost, and high average power which affects the operation cost. In general, this can be accomplished with frequencies less than 60 Mc.

Another method is to use two or more frequencies. These would be chosen to allow operation above the MUF when in use. A marked savings in the average power required would be achieved this way. However, as in the fixed frequency case, there is a need for transmitters of higher power than are presently available.

A third method would be to use a given frequency which may be part of the time above the MUF and part of the time near or below it. This would combine the advantages—and disadvantages of both the previous methods. Operations in this manner, however, requires special engineering to overcome the multipath phenomenon, although these are less significant for voice than for teletype circuits. Continued work is needed on improved antennas and improved modulations techniques which are appropriate for voice transmissions.

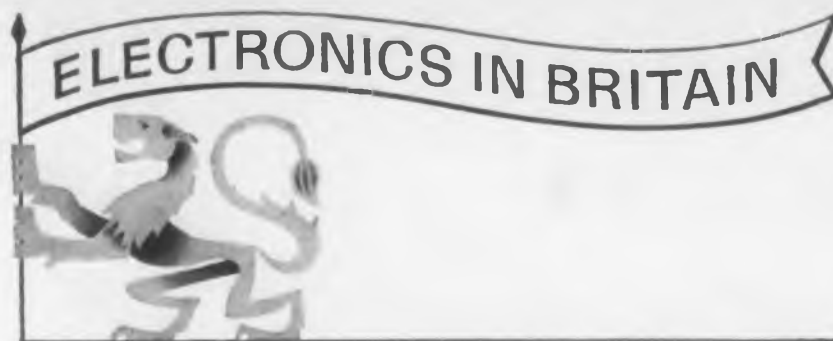
The Conference closed with the thought that great progress had been made in the technique of ionospheric scatter, but that much work has yet to be done.

Where Do You Stack Up?

The Department of Defense recently released its list of the top 100 military prime contractors of 1955-56. They received 69.6 per cent (\$24.8 billion) of the total U.S. dollars spent for defense. They also own 50 per cent or more of the stock of 168 other companies which are military prime contractors. DOD further reports that 197 large prime contractors "volunteered" the information that they paid out to all subcontractors 56 per cent of their total receipts for military work. They also paid out 21 per cent to small business subcontractors.

Of the top 100, more than 30 companies fall in the electronics industry category. New members of the exclusive club for this period include Minneapolis-Honeywell, Lear, Westinghouse Air Brake, Dynamics Corp., Rand, Thompson Products, and Cal Tech. Companies not making the first hundred during the two-year period are Kaiser, Hazeltine, Sylvania, and Admiral.

The listing that follows gives the company name and its relative ranking among the hundred. Income from affiliates, subsidiaries, and



Infra-red photoconductive cells of exceptional sensitivity



These two cells can be classed among the most outstanding recent British achievements in electronics. Specially designed for detecting infra-red radiations, they combine an unusually high order of sensitivity with an extremely fast response peaked at a wavelength of 2-3 microns. Their spectral range extends beyond the usual limits of infra-red detectors down to the red end of the visible spectrum.

The high signal-to-noise ratios of the 61SV and the 61RV make them ideal for measuring small temperature variations of relatively low heat sources down to 100°C. Additionally, their small size and rugged construction qualify them for the majority of infra-red applications in industry.

For further technical information and advice on the use of these outstanding photocells please write to either of the distributing companies listed here.

Principal characteristics

	61SV	61RV
Peak spectral response	2.5 μ	2.5 μ
Spectral range	0.3 to 3.5 μ	0.7 to 4.5 μ
Cell resistance (maximum)	4M Ω	150k Ω
Max. applied voltage	250V	100V
Minimum detectable power at 2 \pm 0.5 μ	5.5 x 10 ⁻¹¹ W	2.6 x 10 ⁻¹⁰ W
Time constant	75 μ secs.	15 μ secs.
Construction	Lead Sulphide (uncooled)	Lead Selenide (uncooled)

Supplies available from: in the U.S.A.

International Electronics Corporation,
Dept. ED 11, 81, Spring Street, N.Y. 12,
New York, U.S.A.

in Canada

Rogers Majestic Electronics Limited,
Dept. JK, 11-19 Brentcliffe Road,
Toronto 17,
Ontario, Canada

Mullard is the Trade Mark of Mullard Limited and is registered in most of the principal countries of the world.



MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND
MEV 55

CIRCLE 17 ON READER-SERVICE CARD

Mullard

ELECTRONIC TUBES

used throughout the world

an ideal
result....



the A-B hot-molded
composition resistor...
HERMETICALLY SEALED!

● Here's a line of composition resistors that assures you virtually ideal characteristics *plus* complete freedom from catastrophic failures. Because of their ceramic enclosure and high temperature hermetic end seals, these hot-molded composition resistors are unaffected by humidity and moisture. Furthermore, they have an extremely low noise level. All microphonic noise, occasionally encountered in composition resistors due to shock and vibration, has been eliminated. Their unusual rugged construction, and

uniformity of size and configuration make these resistors ideal for mechanical handling.

Special techniques have made it practical to increase the operating temperatures beyond the rating heretofore considered "good practice." The Type ES, 1 watt resistor can be operated safely at 165° C without load; the Type TS at 110° C under the same conditions. Available in tolerances of 2% and 5%; in resistance values from 2.7 ohms up.

Write for Technical Data

Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Limited, Galt, Ont.

**Allen-Bradley Hermetically
Sealed, Hot-Molded
Composition Resistors, Type TS
(1/8 watt) and Type ES (1 watt)**

ALLEN-BRADLEY
RADIO, ELECTRONIC AND TELEVISION COMPONENTS
QUALITY

CIRCLE 18 ON READER-SERVICE CARD

Washington Report

divisions are lumped together to produce the corporate standing. General Dynamics (2), General Electric (5), AT & T (9), Hughes (11), Martin (13), IBM (14), Bendix (17), Raytheon (19), RCA (20), Sperry-Rand (21), Westinghouse (23). Also, AVCO (24), Northrop (25), Philco (30), General Precision Equipment (35), Burroughs (40), American Bosch Arma (42), Minneapolis-Honeywell (45), IT & T (47), Collins (49), MIT (52), Gilfillan (55), ACF (60), Lear (69), Motorola (78), Westinghouse Air Brake (81), Dynamics Corp. (88), AMF (93), Rand (94), Thompson Products (5), and Cal Tech (100).

Top prime contractor is Boeing Airplane Company, receiving \$1.9 billion (or 5.4 per cent of the total) for the two-year period. Among the other top 10 are: General Dynamics (4.9%), North American Aviation (4.8%), United Aircraft (4.7%), General Electric (3.6%), Lockheed Aircraft (3.3%), AT & T (2.9%), Ford (2.4%), Douglas (2.4%), and McDonnell Aircraft (1.9%).

Airways Modernization Board Finds Support

The President has issued an executive order that . . . authorizes the Airways Modernization Board, with the approval of the President, to transfer to itself functions of the Department of Defense or Commerce which relate primarily to developing, testing, evaluating, or selecting systems, procedures, facilities, or devices for safe and efficient air navigation and air traffic control. The statute further authorizes the President, in connection with such transfer of functions, to provide for appropriate transfers of records, property, and civilian personnel to the AMB.

DOD Overtime Problems Still Hazy

Sputnick and budget limitations have combined to make the life of a DOD procurement officer more hectic than usual. Recently, a "clarifying" directive on the overtime restrictions to industry was issued. It did little to clarify the problem. There are still very narrow conditions by which overtime may be legally granted. A company can still allow it, but it takes the risk of paying for the overtime out of profits if the contracting officer cannot be convinced of its need.

The Defense Department has also considered those companies having contracts in one plant with two or more of the military services. The services involved *must* select a single contracting officer to represent all on matters of overtime

CIRCLE 19 ON READER-SERVICE CARD >

the
en-
(1),
eon
ng-
(25),
(35),
(12),
Col-
(30),
Air
(33),
Cal

om-
c of
the
(%),
raft
Air-
glas

der
ion
to
of
r to
sys-
afe
rol.
in
to
ds,

om-
ent
ari-
to
the
ons
A
risk
the
its

red
ant
The
ing
me
D >



BACKGROUND OF QUALITY



... and the quality starts in the foreground!

For when it comes to Roebling Magnet Wire, *quality* means—unsurpassed ingredients of consistent excellence... wire-making skill based on decades of experience... and exacting testing and inspection.

You pay no more for Roebling Magnet Wire—you get more in terms of satisfying performance. And *you* choose the packaging that will give you utmost efficiency and



economy. Write today to Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, for information about types and sizes of Roebling Magnet Wire exactly suited to your applications.

ROEBLING

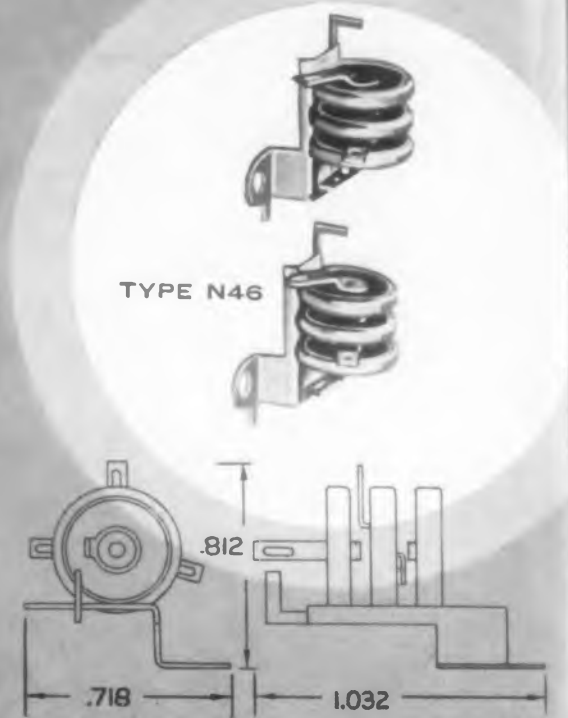
Branch Offices in Principal Cities

Subsidiary of The Colorado Fuel and Iron Corporation



for your
miniaturized equipment...

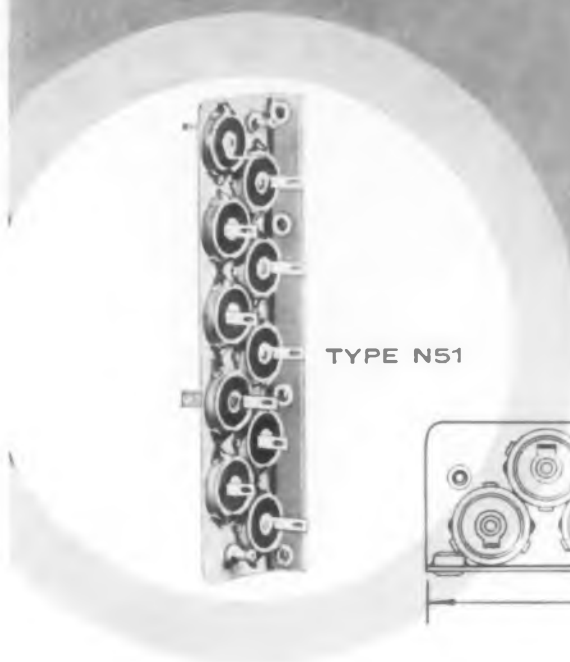
SANGAMO pre-mounted Button® Capacitor Assemblies



simplify circuits...

save space...

solve mounting problems!



Sangamo Multi-section Button Assemblies are silvered mica button capacitors, pre-mounted in silver-plated non-ferrous brackets. They are easy and inexpensive to mount in miniaturized equipment where many buttons must be installed in a small space. These multiple assemblies supply their own common circuitry—retain the low inductive design advantages of conventional button mica capacitors—are

ideal for use in VHF and UHF circuitry.

Two types and dimensions of assemblies in the Sangamo series are shown above. Any suitable combination of buttons may be selected for mounting. All Sangamo button type mica capacitors used in these assemblies conform to military specification MIL-C-10950B.

Write for complete information and prices.

SANGAMO

Electric Company
SPRINGFIELD, ILLINOIS

Ever
living
to be n
will no
tory st
enmer
a lower
contra
appro
shall b
militar
chang
deadli
come
are no
being
To be
contra
escala
time a
This
for stu

Defens
Electro

Stano
reache
Defens
reduce
ment
numbe
approv
switch
visible
mentin
examp

1959,
drastic
bough
specifi
up gu
design
Star
month
ificat
tion n
storag
is exp
from

In
compe
plans
before
pletio
end b
the su

← CIRC

ELEC

Even those contracts that have provisions allowing overtime are no longer secure. These are to be reviewed. If it is found that the overtime will not hasten the schedule according to military standards, or be less expensive to the Government, or remove a bottleneck, or is being allowed in the absence of an emergency, the contractor will have to stop authorizing it. Where appropriate, performance and delivery schedules shall be extended. In some cases, however, the military is asking that the schedules not be changed. Therefore, the cost of meeting the deadline must be borne by the contractor and come out of expected profits. And the primes are not alone in this review. Consideration is being given to major first-tier subcontractors, too. To be tapped first are those working under prime contracts providing for price redetermination, escalation, in incentives; or cost-reimbursements, time and material, and labor-hour type contracts. This doesn't leave many other types not open for study and review.

Defense Works Toward Standardizing Electronic Components

Standardization of electronic components has reached the upper echelons of the Department of Defense. The efforts of the military services to reduce the number and complexity of such equipment has finally been recognized. Recently, a number of plans for standardization have been approved. Effected are resistors, capacitors, switches, lugs and terminals, and visible and invisible light equipment. The deadline for implementing each plan is three years. Resistors, for example, are expected to be standardized by April 1959. In very simple terms, the plans call for a drastic reduction in the number of pieces being bought by the Federal Government. Ultimately, specifications and standards will be written setting up guided lines to which the military buyer and designer must adhere.

Standardization action taken in the first six months of this year consolidated 111 separate specifications into 43 single specifications. The reduction made available over 2.3 million cubic feet of storage space and saved over 76,000 manhours. It is expected to eliminate an estimated 86,230 items from the military supply system.

In total, about 120 classes of equipment and components out of 530 have plans. Standardization plans for the remaining 410 must be formulated before 1961. If three years are allowed for the completion of each plan, the whole program should end by 1964. That's a total of 12 years to clean up the supply system of the Federal Government.

◀ CIRCLE 20 ON READER-SERVICE CARD



a quick check of indent-depth tells you this electrical connection is safe!

There's no way to check a soldered connection—without destroying that connection! The modern Burndy crimping method affords a quick check for electrical and mechanical safety—simply by measurement of this depth of indent. The cross-section view (right) shows how this indent is designed to coin conductor and connector into intimate contact...for a strong connection, as electrically sound as the conductor itself. And the depth of indent is controlled by the installation tool! Unlike solder which can weaken at high temperatures frequently encountered by modern equipment, the Burndy crimped connection with its wide tolerance endures in all environments. Too—Burndy electrical connections get rid of human error—no skill or training is required. The control is engineered into the connector and the tool! Put a crimp on rising production costs!—send for the full story on Burndy crimp-type connections, today!

first piece check guarantees electrical connections for the entire production run

BURNDY

57-13

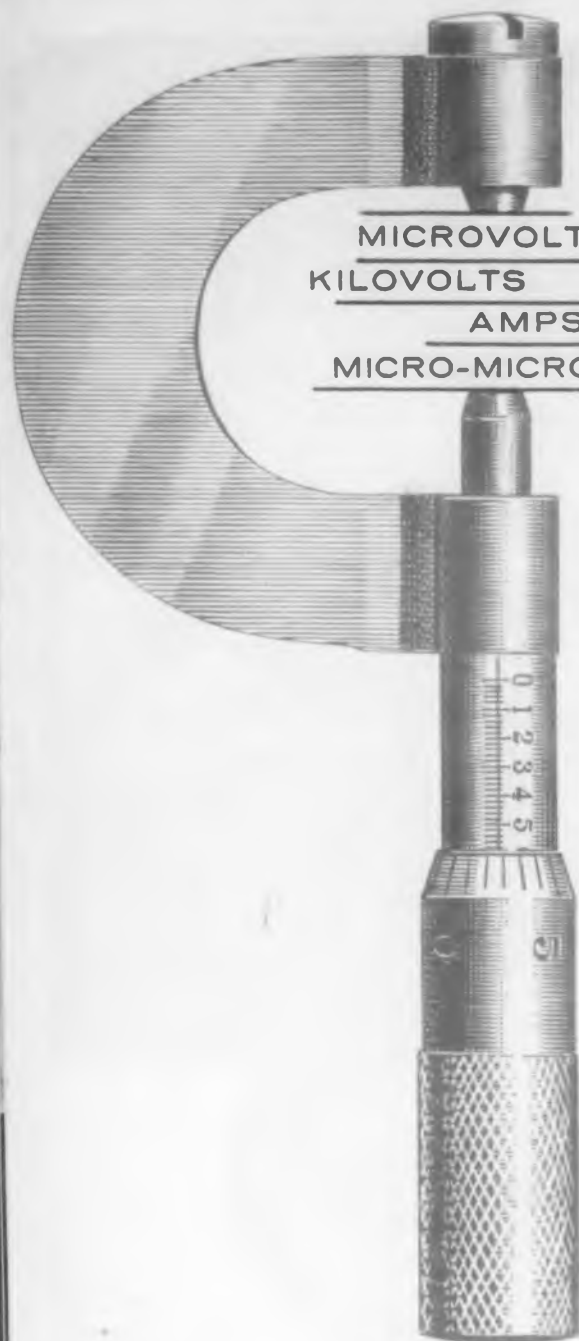


Norwalk, Connect.

Export: Philips Export Corp.

Toronto, Canada

CIRCLE 21 ON READER-SERVICE CARD



Now! Solve any DC measurement problem—with a proven KIN TEL instrument

MEASURE MICROVOLTS TO KILOVOLTS, MICRO-MICROAMPS TO AMPS WITH STABILITY, ACCURACY, SIMPLICITY!

From research and development to production line testing...one of these versatile DC measuring instruments can meet your most exacting requirements.

All units incorporate KIN TEL's proven chopper-stabilized circuitry for rock-solid measurement of microvolt level DC signals. All have zero center meters for instant polarity indication.

KIN TEL's microvoltmeters feature high input impedance and can be used as stable DC amplifiers. The model 301 both measures and supplies DC from 1 to 501 volts with 0.02% accuracy - provides 20 ma output as a supply.

One of these instruments can solve your DC measurement problem. And remember - reliable, accurate performance is assured by KIN TEL's experience in manufacturing more than 10,000 instruments.

Instrument	Model 203	Model 202B	Model 204A	Model 301	Model 203AR
DC Voltage Ranges (Full Scale)	±100 μ v to ±1000V 15 ranges	±300 μ v to ±1000V 14 ranges	±10 μ v to ±10V 7 ranges	1 to 501 volts*	±100 μ v to ±1000V 15 ranges
DC Current Ranges (Full Scale)	±100 μ ma to ±100ma 10 ranges	None	±0.001 μ a to ±1ma 7 ranges	Not Applicable	±0.001 μ a to 1 amp 19 ranges
Input Impedance	10 megohms below 10mv-30 megohms at 30mv-100 megohms above 30mv	10 megohms below 10mv-30 megohms at 30mv-100 megohms above 30mv	10,000 ohms	Infinite at null	10 megohms at 30mv and below 100 megohms above 30mv
Measurement Accuracy	3%	3%	3% on 2 lower ranges, 4% above	0.02%	3%
Max. Output as Amplifier	1 volt across 1000 ohms	1 volt across 2000 ohms	1 volt across 1000 ohms	Not Applicable	1 volt across 500 ohms
Equiv. Input Drift (Max. Long Time)	10 μ v	15 μ v	<2 μ v	0.01% stability	10 μ v
Price	\$550	\$350	\$325	\$625	\$550

*The 301 utilizes a null voltmeter to indicate difference between voltage being measured and output of its variable DC supply. Its null meter has 4 full scale ranges from ±0.05 to ±50 V.

Write for detailed literature - 5725 Kearny Villa Rd., San Diego 11, Calif. Representatives in all major cities.

KIN TEL

FORMERLY KAY LAB



Model 203. Measure 10 microvolts to 1 kilovolt, 100 μ ma to 100 ma. 25 ranges. This is the ONE universal meter.



Model 202B. Wide range, DC microvoltmeter-amplifier. Zero center meter gives instant polarity indication.



Model 204A. Electronic galvo. Transistorized. Sensitive, rugged DC null detector, amplifier, microvoltmeter, micro-microammeter.



Model 301. Calibrated null voltmeter and DC standard. Instantly measure and supply DC from 1 to 501 volts at 0.02% accuracy.



Model 203AR. Measure 0.001 μ a to 1 amp, 100 μ v to 1000 volts. Zero center meter. Compact, 19-inch rack mount design.

CIRCLE 22 ON READER-SERVICE CARD

Meetings

Dec. 3-4: Joint Symposium on Human Factors in Systems Engineering

Penn-Sherwood Hotel, Philadelphia, Pa. Sponsored by the Philadelphia Sections of the IRE and the Professional Group on Military Electronics and by the Human Factors Society of America. There will be sessions devoted to engineering approaches to systems synthesis, human factors approaches to systems synthesis, and human factors information. There will also be a panel of engineers and human factors experts. Requests for information should be addressed to Conrad Fowler, American Electronic Labs., 121 N. 7th St., Philadelphia, Pa.

Dec. 9-13: Seventh Eastern Joint Computer Conference and Exhibit

Sheraton-Park Hotel, Washington, D.C. Sponsored by the IRE, the Association for Computing Machinery, and the AIEE. "Computers with Deadlines to Meet" will be the central theme. Session heading and paper titles are below.

Mon. a.m., Dec. 9

Industrial Control Computers and Instrumentation—I

THE ELECTRONIC PHASE SHIFT DECORDER. G. T. Moore, Concord Controls, Inc.

SYSTEMS DESIGN OF A NUMERICALLY CONTROLLED MACHINE TOOL. E. C. Johnson and Y. C. Ho. Bendix Aviation Corp.

LOGICAL ORGANIZATION OF THE DIGIMATIC COMPUTER. J. Rosenberg, Electronic Control Systems, Inc.

THE MASTER TERRAIN MODEL SYSTEM. J. A. Stieber, U.S. Naval Training Device Center.

Mon. p.m., Dec. 9

Industrial Control Computers and Instrumentation—II

A COORDINATED DATA PROCESSING SYSTEM AND ANALOG COMPUTER TO DETERMINE REFINERY PROCESS OPERATING GUIDES. C. H. Taylor, Fischer and Porter Co.

SYSTEM CHARACTERISTICS OF A COMPUTER-CONTROLLER FOR USE IN THE PROCESS INDUSTRIES. W. E. Frady and M. Phister, Jr., Ramo-Woolbridge Corp.

REAL-TIME HYBRID COMPUTERS FOR ELECTRONIC CONTROL SYSTEMS. C. T. Leondes, University of California.

REAL-TIME PRESENTATION OF REDUCED WIND TUNNEL DATA. *M. Bain and W. Hoover, Jet Propulsion Lab.*

MECHANIZATION OF LETTER MAIL SORTING. *I. Rotin, National Bureau of Standards.*

Tues. a.m., Dec. 10

Traffic Control, Navigation and Surveillance—
PREPARATIONS FOR TRACKING AN ARTIFICIAL EARTH SATELLITE AT THE VANGUARD COMPUTER CENTER. *D. A. Quarles, Jr., International Business Machines Corp.*

USE OF A DIGITAL COMPUTER FOR AIRBORNE GUIDANCE AND NAVIGATION. *S. Zadoff and J. Rattner, Sperry Gyroscope Co.*

EXPERIMENTATION ON THE HUMAN OPERATOR TIE-IN TO AN AIRBORNE NAVIGATION COMPUTER CONTROL SYSTEM. *C. A. Bennett, International Business Machines Corp.*

MULTI-WEAPON AUTOMATIC TARGET AND BATTERY EVALUATOR. *A. E. Miller, Burroughs Corp.*

CONTROL OF AUTOMOBILE TRAFFIC—A PROBLEM IN REAL-TIME COMPUTATION. *D. L. Gerlough, University of California.*

Tues. p.m., Dec. 10

Simulation in Real Time

PHYSICAL SIMULATION OF NUCLEAR REACTOR POWER PLANT SYSTEMS. *J. J. Stone, B. B. Gordon, and R. S. Boyd, Battelle Memorial Institute.*

APPLICATIONS OF COMPUTERS TO AUTOMOBILE STABILITY AND CONTROL PROBLEMS. *R. H. Kohr, General Motors Corp.*

COMBINED ANALOG-DIGITAL SIMULATION OF SAMPLED DATA SYSTEMS. *H. K. Skramstad, A. A. Ernst, and J. P. Nigro, National Bureau of Standards.*

RESERVATIONS COMMUNICATIONS UTILIZING A GENERAL-PURPOSE DIGITAL COMPUTER. *R. A. McAvoy, Eastern Airlines.*

STOCK TRANSACTION RECORDS. *A. H. Payne, Melpar, Inc.*

ON-LINE SALES RECORDING SYSTEM. *J. S. Baer, A. S. Rettig, and I. Cohen, Radio Corporation of America.*

THE G.E. INTEGRATED BANK DATA PROCESSING SYSTEM MODEL 2B100. *J. Levinthal, J. Weizenbaum, and H. Herold, General Electric Co.*

FACILITIES AND INSTRUMENTATION REQUIRED FOR REAL-TIME SIMULATION INVOLVING SYSTEM HARDWARE. *A. J. Thiberville, Convair.*

EXTENDING FLIGHT SIMULATOR TIME SCALE. *E. J. McGlenn, Bendix Aviation Corp.*

ANALOG, DIGITAL, AND COMBINED ANALOG-DIGITAL COMPUTERS FOR REAL-TIME SIMULATION. *W. W. Seifert, Massachusetts Institute of Technology.*

GOOD-ALL
CAPACITORS

THROUGHOUT THE INDUSTRY

Three HEADLINERS from a broad line of fine quality capacitors

GOOD-ALL Type 600-UE Mylar Dielectric... Molded In Epoxy

A general-purpose tubular of extraordinary performance. Priced in the same range as molded paper designs, but a stand-out in stability and resistance to humidity.

SPECIFICATIONS

Dielectric	Mylar Film	Temp. Range	-55 to +125°C
Case	Epoxy	IR at 25°C	100,000 Meg. x Mfd.
Voltage Range	100-1600	Power Factor	0.6% Max.

GOOD-ALL Types 616-G and 617-G Sub-Miniature Metal Enclosed Mylar Designs

Designed to provide EXTENDED LIFE at high temperatures. Rugged, military construction throughout. These lines include a 50-volt series for transistor applications.

SPECIFICATIONS	Temp. Range	Full rating to 125°C, 50% derating at 150°C	
Dielectric	Mylar Film		
Case	Hermetically Sealed	D.C. Voltage Rating	50, 100, 400 and 600
Winding	Extended Foil		

* DuPont's trademark for polyester film.

Good-All EPOXY Coated Ceramic DISCS

Something really new! The tough, durable Epoxy coating provides excellent moisture resistance and high voltage breakdown strength. The lead entries are tightly sealed.

TYPES AVAILABLE	AC Line By-Pass	Type D
Temperature Compensating	Highly Stable	Types E & EE
By-Pass	High Voltage	Type G
Dual Shielded	Transistor	Type H

Immediate Delivery on Standard Items.

Return inquiry card in back of magazine,
and detailed brochures on the above
capacitor types will be mailed
to you promptly.

Soon in stock at your local distributor.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

CIRCLE 23 ON READER-SERVICE CARD

Meetings

Wed. a.m., Dec. 11

Synthesis of Real-Time Systems

THE PLACE OF SELF-REPAIRING FACILITIES IN COMPUTERS WITH DEADLINES TO MEET. *L. Fein, Consultant.*

ORGANIZING A NETWORK OF COMPUTERS TO MEET DEADLINES. *A. L. Leiner, W. A. Notz, J. L. Smith, and A. Weinberger, National Bureau of Standards.*

A PROGRAM-CONTROLLED PROGRAM INTERRUPT SYSTEM. *F. P. Brooks, Jr., International Business Machines Corp.*

A TRANSISTOR CIRCUIT CHASSIS FOR HIGH RELIABILITY IN MISSILE GUIDANCE SYSTEMS. *G. A. Raymond, Remington Rand UNIVAC.*

A METHOD OF COUPLING A SMALL COMPUTER TO INPUT-OUTPUT DEVICES WITHOUT EXTENSIVE BUFFERS. *J. H. Randall, National Cash Register Co.*

THE OPTIMUM SYNTHESIS OF COMPUTER LIMITED SAMPLED DATA SYSTEMS. *A. S. Robinson, Bendix Aviation Corp.*

Wed. p.m., Dec. 11

Traffic Control, Navigation and Surveillance—II

SAGE—A DATA PROCESSING SYSTEM FOR AIR DEFENCE. *R. R. Everett, C. A. Zraket, and H. D. Bennington, MIT Lincoln Laboratory.*

AN/FST-2 RADAR PROCESSING EQUIPMENT FOR SAGE. *H. W. Taylor, E. W. Veitch, and J. Wylen, Burroughs Corp.*

OPERATION OF THE SAGE DUPLEX COMPUTERS. *P. R. Vance, MIT Lincoln Laboratory, L. G. Dooley, Rand Corp., and C. E. Diss, IBM Corp.*

A DIGITAL SYSTEM FOR POSITION DETERMINATION. *D. C. Ross, International Business Machines Corp.*

REAL-TIME DATA PROCESSING FOR CAA AIR TRAFFIC CONTROL OPERATIONS. *G. E. Fenimore, CAA Technical Development Evaluation Center.*

Thurs. a.m., Dec. 12

On-Line Business Systems

DESIGN TECHNIQUES FOR MULTIPLE INTERCONNECTED ON-LINE DATA PROCESSORS. *F. J. Gaffney and S. Levine, Teleregister Corp.*

Thurs. p.m., Dec. 12

Digital Communications Techniques

DERIVATION OF BUSINESS MACHINES DATA CHANNELS FROM STANDARD TELEPHONE LINES FOR SIMULTANEOUS TRANSMISSION WITH SPEECH. *E. Hopner, International Business Machines Corp.*

A SELF-CHECKING SYSTEM FOR HIGH-SPEED



meters for every

Custom-built or Stock, Simpson Offers a Complete Line

To meet your special requirements, Simpson can build electrical panel meters in many combinations of size, range, type, and style. For meters in small quantities, you can select from 60,000 stock units (over 900 sizes and types) available for *immediate delivery* through your Electronic Distributor. Many stock models now have the *self shielded* Core Magnet Meter Movement.

These fine panel instruments are known throughout industry for their ruggedness and long-lived accuracy. Write today for Technical Manual No. 17.



SIMPSON ELECTRIC COMPANY

5200 W. Kinzie St., Chicago 44, Ill.
Phone: ESTebrook 9-1121
In Canada:
Bach-Simpson Ltd., London, Ontario

instruments that stay accurate



new



EDGEWISE

WIDE-VUE

METER RELAY

ELAPSED TIME

need... Simpson



CIRCLE 24 ON READER-SERVICE CARD

TRANSMISSION OF MAGNETIC TAPE DIGITAL DATA. *E. J. Casey and D. W. Fritze, Remington Rand UNIVAC.*

COMMUNICATIONS BETWEEN REMOTELY LOCATED DIGITAL COMPUTERS. *F. P. Forbath, Collins Radio Co.*

COMMUNICATIONS SWITCHING SYSTEMS AS REAL-TIME COMPUTERS. *A. E. Joel, Bell Telephone Labs.*

AN INTRODUCTION TO THE BELL SYSTEM'S FIRST ELECTRONIC SWITCHING OFFICE. *R. W. Ketchledge, Bell Telephone Labs.*

TRAFFIC ASPECTS OF COMMUNICATIONS SWITCHING SYSTEMS. *J. A. Bader, Bell Telephone Labs.*

Fri. a.m., Dec. 13

Document Reading, Pattern Recognition and Character Synthesis

THE USE OF AN IBM 704 IN THE SIMULATION OF SPEECH RECOGNITION SYSTEMS. *G. L. Schultz, International Business Machines Corp.*

AN AUTOMATIC VOICE READOUT SYSTEM. *C. W. Poppe and P. Suhr, Fairchild Controls Corp.*

EXPERIMENTAL USE OF ELECTRONIC COMPUTERS IN PROCESSING PICTORIAL INFORMATION. *L. Cahn, R. A. Kirsch, L. C. Ray, and G. H. Urban, National Bureau of Standards.*

OPTICAL DISPLAYS FOR DATA HANDLING SYSTEM OUTPUT. *J. Ogle, Burroughs Corp.*

DEVICES FOR READING HANDWRITTEN CHARACTERS. *T. L. Dimond, Bell Telephone Labs.*

AUTOMATIC REGISTRATION IN HIGH-SPEED CHARACTER SENSING EQUIPMENT. *A. I. Tersoff, Intelligent Machines Research Corp.*

THE NCR HIGH-SPEED ELECTROMAGNETIC PRINTER. *J. M. Seehof, National Cash Register Co.*

Further information about the conference may be obtained from J. A. Howells, General Electric Co., MOSD, Philadelphia, Pa.

Jan. 6-8: Fourth National Symposium on Reliability and Quality Control

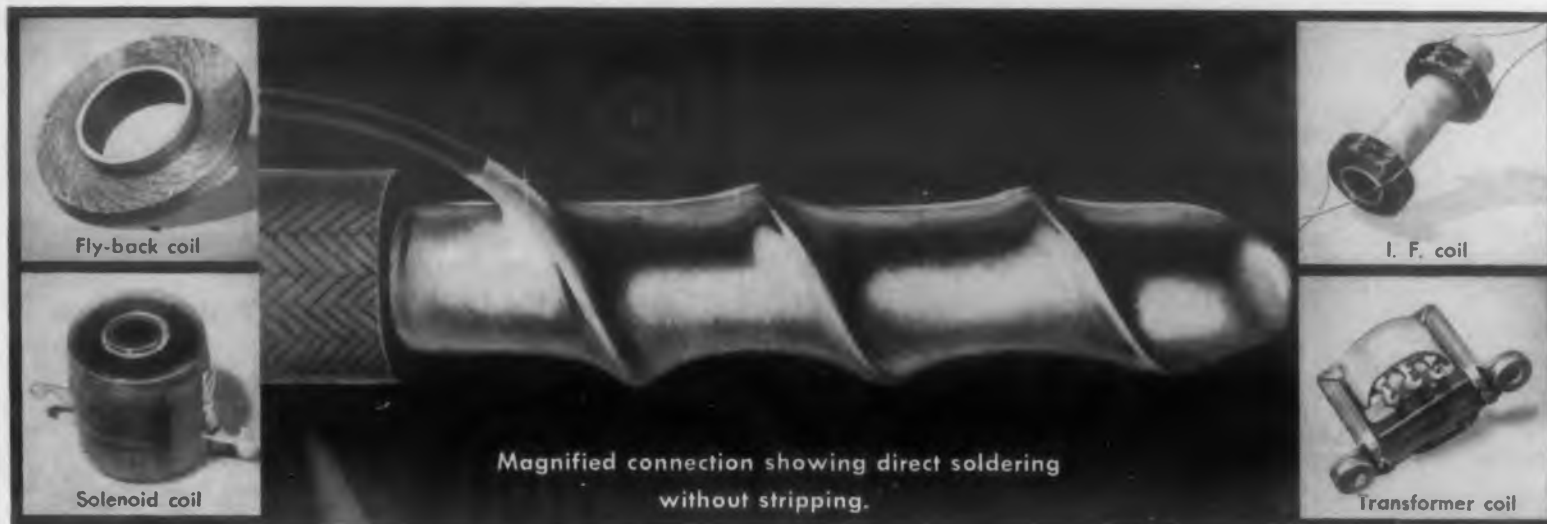
Hotel Statler, Washington, D.C. Sponsored by the IRE, ASQC and AIEE. Covering fields of reliability in the electronic industries, the symposium will encompass the following topics: reliability organization and management; theory and mathematical techniques; application of these techniques; design information; and education and training for reliability. Below is a list of papers and panels.

Mon. a.m., Jan. 6

AGING EFFECTS IN TRANSISTORS. *R. M. Ryder, Bell Telephone Co.*

SIMPLIFIED RELIABILITY EVALUATION. *C. M. Ryerson, Radio Corporation of America.*

PHELPS DODGE SODEREZE® ENDS STRIPPING, CLEANING— CUTS SOLDERING COSTS!



Magnified connection showing direct soldering
without stripping.

Sodereze*—Phelps Dodge polyurethane magnet wire—provides:

1. Low temperature soldering—no damage to copper conductor.
2. A balance of physical, chemical and electrical properties permitting replacement of existing film wires.
3. Resistance to heat and solvent shock for safer wax or varnish treatment.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

*Standard color, red.

FIRST FOR
LASTING QUALITY—
FROM MINE
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

CIRCLE 25 ON READER-SERVICE CARD

Meetings

DETERIORATION AND FAILURE AS A STOCHASTIC PROCESS. *M. L. Norden, New York University.*
THE EFFECTS OF MAINTENANCE ON PART RELIABILITY. *R. L. Madison, Aeronautical Radio, Inc.*
CURRENT MILITARY RELIABILITY SPECIFICATIONS. *D. W. Pertschuk, American Bosch Arma Corp.*
MILITARY REPORTS ON RELIABILITY. *T. M. Child, U.S. Army, J. L. Miller, U.S. Navy, J. S. Lambert, U.S. Air Force.*

Mon. p.m., Jan. 6

MATHEMATICS AND STATISTICS USED IN RELIABILITY. *N. A. Woodbury, New York University.*
RELIABLE SYSTEM DESIGN BY PART ENGINEERING. *C. G. Walance, Hughes Aircraft Co.*
SYSTEMATIC METHODS IN MISSILE SEEKER SYSTEM DESIGN. *H. V. Cooper, Bendix Aviation Corp.*
RELIABLE DESIGN AND DEVELOPMENT TECHNIQUES. *J. E. McGregor, International Business Machines Corp.*
PANEL ON SYSTEM RELIABILITY MEASUREMENT.

Mon. eve., Jan. 6

RELIABILITY DEFINITIONS PANEL.

Tues. a.m., Jan. 7

ACCELERATED LIFE TEST IN AIRFRAME MANUFACTURE. *M. H. Simpson, General Dynamics Corp.*
ACCELERATED LIFE TESTING TO PREDICT FAILURE RATE. *B. Hecht, Sprague Electric Co.*
STUDY OF ACCELERATED LIFE TEST VERSUS FIELD OPERATION. *J. Kimmel, Radio Corporation of America.*
ACCELERATED LIGHT TEST OF PRECISION RESISTORS. *H. S. Herrick, Erie Resistor Co.*
MECHANICAL AIRLINE EQUIPMENT RELIABILITY ANALYSIS. *A. M. Hull, United Airlines, Inc.*
IMPROVED RELIABILITY BY STABILIZING THE TRANSISTOR. *O. R. Baker, International Business Machines Corp.*
SOME RELIABILITY FACTORS OF ELECTRICAL INSULATION. *N. M. Bashara, University of Nebraska.*
LARGE DIGITAL COMPUTER DEPENDABILITY MEASUREMENTS. *G. B. McCarter, International Business Machines Corp.*

Tues. p.m., Jan. 7

RELIABILITY VERSUS COST OF FAILURE. *G. A. Raymond, Remington Rand.*
THE PRICE OF RELIABILITY. *A. L. Lambert, The Martin Co.*
SIGNIFICANCES OF R AND D—RELIABILITY AND DOLLARS. *E. T. Welmers, Bell Aircraft Corp.*

RELIABILITY COSTS FOR SPARES AT REMOTE LOCATIONS. *R. J. Herman, Bell Telephone Labs.*
 REPORT ON NORTHROP'S TUBE SURVEILLANCE PROGRAM. *D. Hawley, Northrop Aircraft Co.*
 DESIGN AND ANALYSIS OF COMPARISON TESTS ON PARTS. *R. P. Bosley, American Bosch Arma Corp.*
 EVALUATING COMPONENT PARTS BY THE BOX TECHNIQUE. *R. Glaser, General Electric Co.*
 THE MECHANISMS OF FAILURE OF TANTALUM CAPACITORS. *M. E. Krasnow, Inland Testing Lab.*

Wed. a.m., Jan. 8

REASON—RELIABILITY AND REALITY. *L. J. Jacobson, Electronic Industries Association.*
 VENDOR CERTIFICATION PROGRAM. *D. A. Hill, Hughes Aircraft Corp.*
 TEST PROGRAM DESIGN FOR A MISSILE GUIDANCE SYSTEM. *R. P. Grant, American Bosch Arma Corp.*
 COMMERCIAL ASPECTS OF GUARANTEED RELIABILITY. *W. A. MacCrehan, Bendix Radio Co.*
 ORGANIZATION FOR RELIABILITY. *H. Knapp, Federal Telephone and Radio Co.*
 TALOS MISSILE DATA SYSTEM CONTRIBUTES TO MANAGEMENT. *R. R. Wendt, Bendix Aviation Corp.*
 ORGANIZING RELIABILITY IN AIRBORNE EQUIPMENT MANUFACTURE. *J. J. Crowley, General Dynamics Corp.*
 ORGANIZING FOR RELIABILITY AT WESTINGHOUSE. *T. Clark, Westinghouse Electric Corp.*

Wed. p.m., Jan. 8

TECHNIQUES AND RELATIONSHIPS OF QUALITY CONTROL AND RELIABILITY. *J. J. Riordan, Office of Secretary of Defense.*
 CONTROLS FOR RELIABILITY AND QUALITY ASSURANCE. *H. G. Romig, Summers Gyroscope Co.*
 PROPAGATION OF ERROR TECHNIQUES IN ELECTRONIC CIRCUITS. *M. Racite, International Business Machines Corp.*
 VENDOR AND SUBCONTRACTOR LIAISON FOR HIGH RELIABILITY. *J. A. Rice, American Bosch Arma Corp.*
 TALOS RELIABILITY AND QUALITY EDUCATION PROGRAM. *W. H. Johnson, Bendix Aviation Corp.*
 EDUCATION AND ENGINEERING RELIABILITY. *A. B. Credle, International Business Machines Corp.*
 TRAINING EVALUATION ENGINEERS FOR RELIABILITY PROGRAMS. *L. W. Ball, Stelardyne Lab.*
 TRAINING THROUGH DESIGN REVIEWS. *H. C. Bryson, Jr., Radio Corporation of America.*
 For information, contact Richard M. Jacobs, Radio Corporation of America, Bldg. 108-2, Moorestown, N.J.

New from Clevite!

SILICON

JUNCTION DIODES



These latest additions to Clevite's complete line of computer and general-purpose diodes offer you the advantages of:

ULTRA FAST RECOVERY TIME . . . (JAN-256)
 (Typical: from +5.0 ma to -40v
 . . . 400K in 0.3 μ s)

HIGH FORWARD CONDUCTANCE
 (Typical: 50 ma at 1.5v)

EXTREMELY LOW REVERSE CURRENT

FREEDOM FROM THERMAL RUNAWAY
 at high voltage and up to 150°C

RUGGED, HERMETICALLY SEALED GLASS PACKAGE

*For complete information,
 write or phone:*

CLEVITE

TRANSISTOR PRODUCTS

241 Crescent St., Waltham 54, Mass.
 TWInbrook 4-9330

A Division of



OTHER CLEVITE DIVISIONS:

Brush Instruments

Clevite Ltd.

Clevite Ordnance

Texas Division

Cleveland Graphite Bronze Co.

Clevite Harris Products, Inc.

Clevite Electronic Components

Clevite Research Center

Intermetall G.m.b.H.

CIRCLE 26 ON READER-SERVICE CARD



1

Planning for Low-Cost Production

This staff report is intended to point up production considerations that can affect design. Included are many specific design recommendations to aid in assuring lowest cost end products. To aid in quick reading and reference, the report is divided into 12 sections as follows:

1. Planning for Low-Cost Production
2. Prototype Design Compatible with Production
3. Save Costs in Drafting
4. Standardization
5. Selecting Materials and Components for Low-Cost Production
6. Labor Savings with Printed Wiring
7. Sheet Metal Design
8. Cost Savings with Plastics
9. Packaging for Economy
10. Process Evaluation and Value Analysis
11. Hand Assembly vs Automatic Production
12. Designs for Low-Cost Production

The Editors are particularly indebted to the firms shown below for information used in preparing this report. A number of those listed granted personal interviews with their engineering and production specialists. To these individuals and their firms we wish to express our deep appreciation for allowing us to share their knowledge and experience with our readers. **ETE**

IF THERE EVER was a time when designs could be created in a vacuum without thought of how they could be produced and at what cost, that time has long passed. This report will attempt to show not only why this is so but what kind of design thinking should go into planning for low cost production. Often in the past functional design has been uppermost in the minds of engineers designing new products, with costs coming secondary. It may seem surprising to learn that the editors of **ELECTRONIC DESIGN** found many companies designing around production processes as the number-one consideration. Such companies, however, have found that function is achieved, generally without special effort, even though the emphasis is on low-cost production.

ACKNOWLEDGEMENTS

Aabab Enterprises; Admiral Corp.; Aero Service Corp.; Allen B. DuMont Laboratories, Inc.; American Machine and Foundry Co.; Applied Psychological Services; Army Signal Engineering Labs.; Bakelite Co., Div. of Union Carbide Corp.; Battelle Memorial Institute; Centralab Div., Globe-Union Inc.; Chicago Aerial Industries; Curtiss-Wright Corp.; Design Tool Corp.; Federal Telecommunication Labs.; Filtron Co., Inc.; General Electric Co.; Grayhill, Inc.; Gulston Industries, Inc.; Halm Instrument Co., Inc.; Hewlett-Packard Co.; International Business Machines Corp.; Mark-Simpson Manufacturing Co., Inc.; Minneapolis-Honeywell Regulator Co.; MIT Lincoln Laboratories; Motorola, Inc.; National Research Corp.; Navy Bureau of Aeronautics Avionics Div. (NAFI); Photocircuits Corp.; Raytheon Manufacturing Co.; Shakeproof Div. of Illinois Tool Works; The Society of the Plastics Industry, Inc.; Stavid Engineering Inc.; Stromberg-Carlson Co., Div. of General Dynamics Corp.; Sylvania Electric Products, Inc.; Temco Aircraft Corp.; United Shoe Machinery Corp.; U.S. Navy Bureau of Ships; U.S. Navy Electronics Lab.; Virginia Electronics Co., Inc.; Westinghouse Electric Corp.; Weston Electrical Instrument Corp.; Whitso, Inc.; Zero Manufacturing Co.

Team Planning Comes First

In one leading company manufacturing TV receivers and radios, the electrical, mechanical, appearance design, and production people get together at the outset of a design. They talk over and plan the initial phases of a design and coordinate activities together throughout design to finished production. Careful evaluation is given to all competitors' products, and an effort is made to find out what the competition is planning to do next. Marketing people are brought in as part of the team at a first meeting; and as the head of a commercial engineering department of a large electronic company expressed it,



Automatic Component Assembly System (courtesy, General Electric Co.)

"Be sure marketing people spell out with engineering at the outset 'no-fooling' product specifications." In other words, the objective must be clear at the outset; otherwise, engineering deadlines will never be met, because no one will know when the product has been adequately designed.

The Planning Schedule. It may seem to go without saying that a Master Production Schedule must be prepared before any work begins on a design project. Nevertheless, such schedules are often either not realistic or are not considered binding, particularly on engineering. If costs are to be saved, the schedule originally set up must be rigidly adhered to. There will be instances, of course, where certain phases of a design cannot be completed on the exact schedule initially outlined, but except where absolutely unavoidable, such delinquency should not prevent other phases of the schedule from starting on time.

If any phase does not start on time, it cannot be expected to finish on schedule. Some phases of the schedule should be completed earlier than initially thought possible, and these should balance out those that take a greater length of time due to unavoidable circumstances. A typical planning schedule for BuShips Electronic equipment lists the various items which went into the planning. Some similar schedule should be made up for all designs whether military or commercial.

R & D Responsibility for Low Cost

Leon Himmel of I.T.T.'s Federal Telecommunication Labs, where much preproduction engineering R & D is accomplished, has outlined responsibilities of research and development people in considering production costs. He states that R & D to the government and industrial laboratories alike is a means to a desired production end item. "It is that area of engineering related to the advancement of the state of the art, yielding techniques and developments which in time can be applied to an end product. Usually there is a great sense of urgency associated with meeting an operational requirement of the customer who in general has every expectation of obtaining a successful solution leading to early production.

"In many cases much of the extensive redesign required results from the failure on the part of the original designer to realize he was depending upon characteristics of a component which were not or could not be controlled economically in production. It is common on the part of many designers to fail to take the tolerances and stabilities of the components they use into consideration.

"From an economic point of view alone, a relatively small improvement in reliability can involve enormous savings. The reliability can be bought partly from adequate design and partly from experience in the use of a particular

piece of equipment refined by the attendant changes or modifications required in the development. Valuable time and experience in an equipment configuration can be obtained by starting an R & D program on the right foot. In a crash program the luxury of sequential redesigns is out of the question. In view of the fact that production lead times are effectively becoming shorter and shorter, it is extremely important that every advantage be taken of the available time during the R & D phase.

"There may be arguments that Research and Development funds should be used to the utmost for research exclusively and that little or no attention be paid to hardware, stability, reproducibility, etc. This point assumes that attention to the practical realities of our business is costly and stifling to research. This is not the case at all. A management that encourages this state of mind is doing itself, its employees, and the customer an injustice. An adequate training program coupled to professional standards can result in consistently high quality design and workmanship at no extra cost. It is the responsibility of engineering management to set the standard and control the product, for like most other people, *engineers do best that which is 'inspected' of them.*"

Efficiency in Design Department

One small company that has had unusual financial success, sets down several rules for office efficiency:

- Line up jobs so that people don't have to run around. Material and papers should flow to one's desk for efficient operation rather than for the individual to get up and move around.
- Close supervision of personnel is important. Know what they are doing, what their problems are, and get the problems corrected before it costs the company "an arm and a leg."
- Make every piece of paper do more than one job, if at all possible.

A large company employs a suggestion system for hourly workers and has a profit improvement program for salaried employees. The purpose of these is not only to improve the morale of the workers but to get into the system all good ideas from those who are in a position to offer them. At the U.S. Naval Avionics Facility at Indianapolis production people are upgraded to technicians as they become able to assume the additional responsibilities. They have found that production workers have the necessary production knowhow to introduce cost saving ideas at the design stage.

Designers Responsibility for Low-Cost

Time and again we were told that "Low cost must be designed in." Typical of the set up of



Design for LOW-COST PRODUCTION

many companies doing electronic design work, the project engineer is an electronic engineer and is fully responsible for all aspects of the design clear through production. He maintains close liaison with production, and in some ways he is prevented from going astray by standardization "curbs." His success and advancement depends to a great extent upon his ability to achieve designs that produce good profits for the particular division of which he is a part.

What Makes Designs Unproducible?

We asked this question of both military people and commercial firms. The main reasons given were these:

- Complexity.
- Tight tolerances.
- Unworkable materials.
- Lack of understanding by the designer as to what manufacturing can do.
- Failure to consider facilities and techniques used in the factory.
- Well designed electrically but poorly designed mechanically.
- Electronic engineer does engineering work for which he is not experienced.
- Performance specifications are not sufficiently appreciated by the designer.
- Lack of proper performance testing after equipment design.
- Designer has aversion to using a standard part.
- Part and assembly drawings are inadequate.

Military vs Commercial

Squeezing cost out of equipment designed and built for the military establishments is an art in itself. Contrary to some popular belief, we are convinced that the military is just as anxious to cut the cost of such designs as are manufacturers themselves. Part of the trouble seems to be misunderstanding. Capt. William I. Bull of BuShips speaking before a recent Washington Symposium on Production Techniques stated "The Military is interested in any method to keep costs

down." Military equipment production is characterized by relatively small quantities, very little circuit interchangeability and a need for ease of maintenance. Capt. Bull further stated that: "In the military organization there is strong resistance to change. The maintenance man likes to see components and equipment with which he is familiar. He will resist peculiar looking gear which is the product of mass automation." He and others with whom we talked in the Services were particularly anxious for standardization of components or small functional modular units. Although no one directly turns thumbs down on printed circuitry, there are those who are not sold on it for military equipment. Reasons are that this goes back to the problem of maintenance. Technicians are unfamiliar with repairing printed circuitry, which is different if not difficult at times.

Cost-Saving Hints. In addition to general cost-saving design hints mentioned earlier, certain cost-saving hints can be applied more specifically to military contracts.

- Specifications should be clearly defined between the technical people of the cognizant military bureau and engineers at the manufacturing plant. Liaison time costs money as does red tape. Endeavor to secure enough time from the military services to build in reliability which will in turn reduce costs in production. Also, with more time, purchasing can take advantage of lower costs.
- Consider use of light weight material such as magnesium, aluminum, etc. at the outset of design planning.
- Be sure performance specifications are tied down and understood.
- Be sure to stick to master planning schedule.
- Use standard parts wherever possible; modify standard parts where specials are required.
- Be sure before bidding to know thoroughly

what is being bid on.

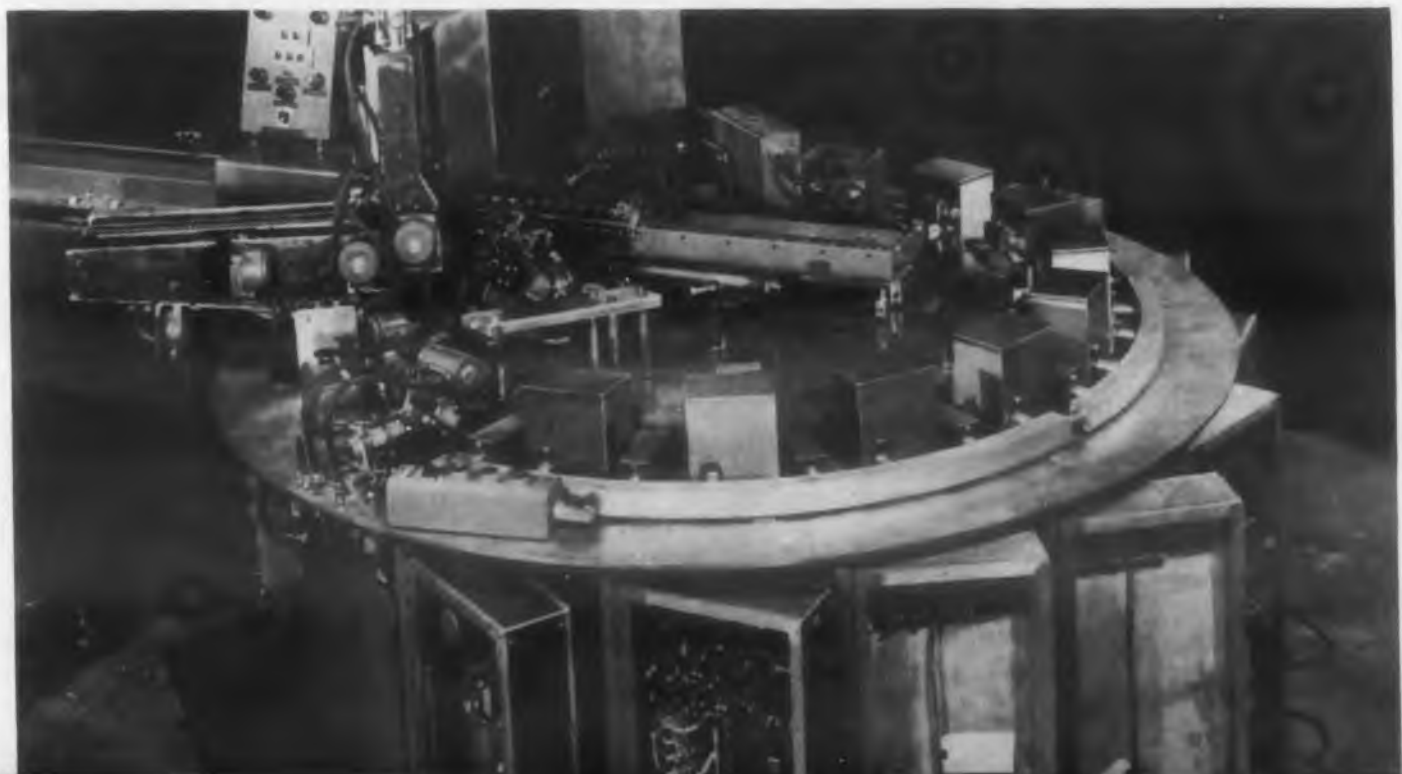
- Read government performance specifications carefully and compare with available prototypes.
- Employ design consultants intelligently.
- Consider maintenance in the design. Make replacement of parts and test points accessible.
- Load the circuit evenly within the design of the equipment for higher reliability. Employ consistent safety factors and avoid "hot" spots.
- Design in as much interchangeability of components and parts as possible.
- Select hardware for low cost and function without concern for interchangeability since this item is not a maintenance item in the military.
- Forget appearance design because appearance is determined by applicable specifications; but watch safety features.
- Use simplified or functional drafting where allowed by the contract.
- Solidify design as early as possible.

Simplicity and Cost

Almost without exception we found that engineering and production people alike agree that the simpler the design the lower it costs to produce. Fewer components provide more room to work in during assembly. An added by-product is ease of maintenance. Easier assembly makes possible use of less skilled labor at lower cost and less hours consumed in production. In addition, inspection time which is relatively costly on the production line, is reduced.

Effect on Reliability by Low-Cost Production Design

It is a rather common belief that where a high degree of reliability is required of an end product, costs cannot be considered. One major company for instance states, "Reliability requirements are so great that low cost is out." Yet, a number of those interviewed took a different



position. One large producer of electronic equipment for the Services stated that it found no adverse effect on reliability because of designing for economical production. Another stated that, "Low cost and reliability go hand in hand." One production man stated, "the simpler it is made, the lower the cost—also, the more reliable." A reliability engineer in one large company who came up the hard way from production stated that most problems in reliability are solved by design simplification which actually reduces production costs.

How Does Low-Cost Production Thinking Affect Design Costs?

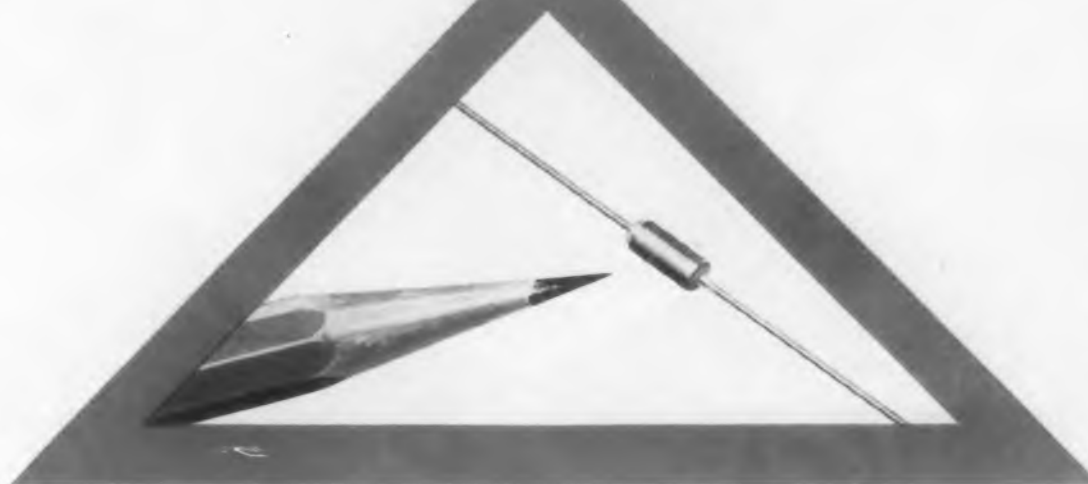
If we take time in engineering to think about squeezing every last cent out of the cost of producing a piece of electronic equipment, will this not increase engineering time consumed and thus increase engineering costs? We asked this question of a number of companies. Apparently some additional costs to engineering will be incurred by watching this factor. However, those companies that have been designing for low cost production state that they keep a close balance on production savings vs increased engineering costs by good liaison between design and production departments. Quantity of production is, of course, a factor, and where only a small quantity of a part or equipment is to be produced, it may not be possible to justify extra time in engineering to assure lower cost production. There is no substitute for good judgment in deciding such issues.

Quantity of Production vs Design

Unfortunately the quantity of items produced in a given production line has a direct bearing upon the design in most cases. It is therefore important that the designer know what production quantities are anticipated at the outset of a design. Designing for die casting, for instance, would not be logical if only a few units were to be turned out. On the other hand, fabrication of a complex part by hand tools and welding techniques would not be economical for large production runs. The selection of material, as well as their shapes would be affected by the quantity of production. Where quantities are small, use of standard components and commercially available chassis, panels, cabinets, etc, are indicated where possible. Special tooling is rarely justified in such instances. As the quantity goes up, one leading manufacturer points out that one can trade piece price for tooling costs and can trade cost of labor for capital expenditures for fixtures and tools. Careful liaison between engineering and production will be required to determine at what volume of production this consideration obtains.

SOLID-ELECTROLYTE TANTALEX CAPACITORS

new dimensions in miniaturization and reliability



This solid-electrolyte Tantalex Capacitor (shown 1½ times actual size) is rated at 4.7 μF, 10 volts d-c, and is only ¼" in diameter by ¼" long.

Now, circuit designers in computers and military electronics have an electrolytic capacitor that offers greater miniaturization than ever before . . . with no sacrifice in reliability. Sprague's recently announced solid-electrolyte Tantalex Capacitors find ideal application in the transistor circuits of these critical fields.

The tiny sintered tantalum anode of Type 150D Tantalex Capacitor is impregnated with a solid, non-corrosive, semi-conductor material which cannot leak under any circumstance. It combines true miniaturization with electrical stability previously unobtainable in an electrolytic capacitor of any type.

Thermal coefficient of these capacitors is sufficiently low and linear so that for the first time a circuit designer can think of an electrolytic in terms of parts per million capacitance change. Nominal value is +500 ppm/°C. The

capacitor may be used without derating over a range from +85°C to as low as -80°C, a temperature at which no other electrolytic has proved useful.

Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 3520B, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Mass.

★ ★ ★

Sprague, on request, will provide you with complete application engineering service in the use of Tantalex Capacitors.

SPRAGUE

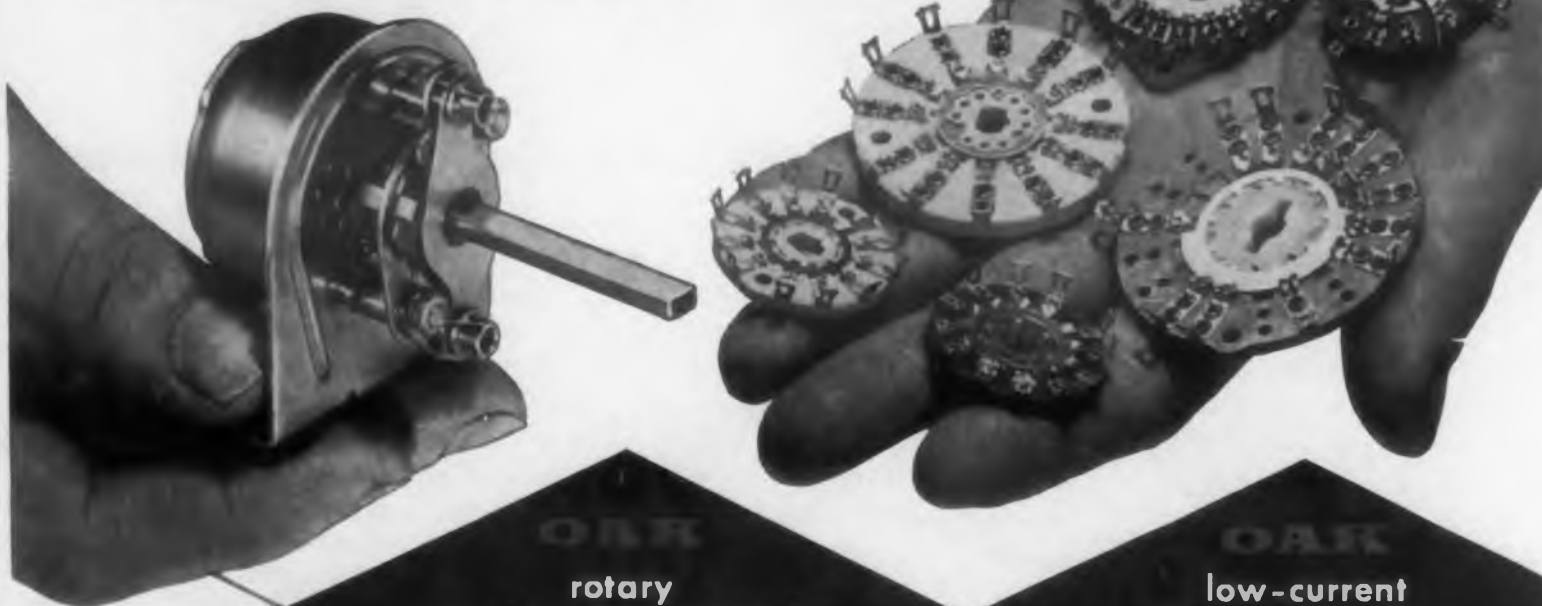
the trademark of reliability

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • HIGH TEMPERATURE MAGNET WIRE • PULSE NETWORKS • PRINTED CIRCUITS
CIRCLE 27 ON READER-SERVICE CARD

thousands of combinations for

REMOTE CONTROL SWITCHING



rotary
SOLENOIDS*

*Mfd. under license from
G. H. LELAND, INC.

low-current
SWITCHES

The variety of Oak switches is almost limitless. Combined with Oak rotary solenoids, they provide an assortment of Rotary Selectors that covers almost any low-current application—simple or complex, military or commercial. Oak Rotary Selectors give a *positive* stepping action, even under severe vibration and shock. To help you get the *exact* remote-control unit you require, Oak engineers will be glad to work out special recommendations. Write for copies of the Oak switch catalog and rotary solenoid bulletin with time-saving layout sheets.

SWITCHES • ROTARY SOLENOIDS •
CHOPPERS • SPECIAL ASSEMBLIES •
VIBRATORS • TUNERS

OAK MFG. CO. 

1260 Clybourn Avenue, Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

CIRCLE 28 ON READER-SERVICE CARD



Design for
LOW-COST PRODUCTION

2 Prototype De Compatible wi

ALL COMPANIES seem to agree on the importance of developing a prototype with full production possibilities in mind. Failing to do so not only requires costly redesign to assure low cost production, but often costs a company that manufactures competitive equipment the advantage in the competitive market because of delays in getting the product through production. Great time saving can be effected between completion of the prototype and beginning of production by keeping in mind how the equipment will be produced and designing the prototype accordingly. Some standard components and circuits might be finalized before the prototype is completed, drawings signed off, and procurement of production quantities authorized even in the prototype stage. This is very important in the case of long delivery items such as transformers and metal work, such as front panels, etc.

One leading company in considering this item has set down two rules:

- Prototype design must depend on production facilities available.
- The first breadboard developed, which occurs approximately 1/3 through the complete design schedule, is turned over to the factory manager and goes to methods and test. A report comes back from the factory making requests for design changes. Each item is gone over carefully by the engineer to determine which items requested can be complied with, which cannot, and what alternatives exist. A meeting between management and engineering is held to resolve differences, and another is held after the final engineering

Design

with Production

model is completed to work out any last minute changes. In this way, by the time the final engineering prototype goes to manufacturing as a model for production, no engineering changes should be required.

Another large company stated that, although in their one division they seldom build more than two or three of a type, the designer should work out his design as though he were building one thousand. In printed circuitry it is just as easy to place holes on 1/10 in. grid in the prototype stage as for production. The only difference between the prototype stage and production in this case would be in the tooling. It would not make sense to tool up for high production where only a few units are being produced. At Sylvania, for instance, one division does research and development while other divisions do the production. They find that the production plants do not want to redesign the prototypes developed in another division after production contracts are obtained. Therefore, it is imperative that the prototype be properly designed for low-cost production.

An excellent way to assure prototype development consistent with low-cost production techniques is to have value engineers work with the designers from the conception of the design. Some companies have such value engineering departments and have found them extremely valuable. Their main function is to consider the lowest cost production methods for given equipment functions. They usually work in a consulting capacity to engineering and manufacturing. Details on value analysis will be given later.

**STOCKED IN RETMA
AND MILITARY TYPES**

FIXTOHM*

PRECISION RESISTORS

Another Clarostat extra! Clarostat Fixtohm precision deposited carbon resistors are in large demand by industrial customers. They are manufactured to MIL-R-10509A specifications. Available in 1/2 watt, 1-watt, and 2-watt sizes, in large range of resistance values. Plus/minus 1% tolerance.



Controls and Resistors

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE
In Canada: Canadian Marconi Co., Ltd., Toronto, Ontario

CIRCLE 29 ON READER-SERVICE CARD

... having your
ups and downs?



... if they involve EQUIPMENT KNOBS

DALOHM

has the answer!

Precision-made Dalohm knobs, incorporating an exclusive collet-fitting design, permit positive locking on the shaft without any of the damaging effects found in other knob securing methods—even when used on soft metal. You can depend on



TYPE K

INDUSTRIAL KNOBS

for hard use at high/low temperatures

- Precision cast of thermo-setting plastic in easy grip shapes
- Knobs fit concentrically on shaft and can be positioned easily and accurately
- Pleasing appearance to match modern styling of apparatus
- Five sizes— $\frac{3}{8}$ ", $1\frac{1}{16}$ ", $1\frac{1}{4}$ ", $2\frac{1}{4}$ ", 3"
- Collets interchangeable for shafts $\frac{1}{8}$ " to $\frac{3}{8}$ "
- Highest quality at lowest price
- Standard escutcheons, pointers and indicators available

Write for
Bulletin
K-29



TYPE MS

MILITARY STYLE KNOBS

in accordance with MIL-K-25049

The incorporation of collet-fitting design into military style knobs offers the ultimate in airborne and other military knob applications.

- Maximum locking pressure on shaft eliminates any slippage from vibration or torque
- Precision made of tough, durable thermoplastic material which is fungus proof. All metal parts are corrosion resistant
- Designed for flatted shafts
- Complete selection of skirts available as required by MIL Specs. Marking of skirts can be to your specific requirements

Write for Bulletin K-35

JUST ASK US!

Write for the complete Dalohm catalog of knobs and precision resistors and potentiometers.

If none of our standard line fills your need, our staff of able engineers and skilled craftsmen, equipped with the most modern facilities, is ready to help you solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

CIRCLE 30 ON READER-SERVICE CARD

DALE
PRODUCTS, INC.

1328 28th Avenue
Columbus, Nebraska
U.S.A.

Export Dept. Pan-Mar Corp.
1270 Broadway
New York 1, N.Y.



Design for
LOW-COST PRODUCTION

3

Save Costs in Drafting

IT IS becoming more and more recognized that old-fashioned mechanical drafting techniques are costly, particularly when not required by government contract. Draftsmen have oftentimes resisted efforts to "simplify" their work, but this is the wrong term to use. Actually, eliminating all nonessentials in the drafting operation leaves time for draftsmen to do the more challenging part of their job—that of design drafting.

Much has been published on simplified drafting, but we were interested in knowing which proposed "simplification" devices are being employed by most companies who have attempted to streamline their drafting departments. The most important short cuts we discovered were as follows:

- Use free-hand sketches wherever possible.
- Avoid detailing assembly drawings.
- Consider glass cloth for drawings from which templates can be made directly.
- Eliminate extraneous views. Show no views at all where a brief description will suffice.
- Use cross lines to locate hole locations—do not draw to scale a specific sized hole but once, referencing all others.
- Use no arrow heads on dimension lines.
- Where a sketch is needed, use photos if available and dimension directly on photo.
- Use keyed legend where possible to indicate

such items as nuts, bolts, and other hardware.

- Avoid use of dotted lines unless needed to clarify.
- Reduce cross-sectioning to a minimum consistent with clarification.
- Avoid hand lettering. Use typewriter for composing notes plus use of strip-ons, etc., to reduce lettering labor involved.
- Use datum lines instead of dimension lines, where possible.

The main thing to keep in mind in considering drafting techniques is the purpose of the drawings concerned. If the purpose can be served equally well by a free-hand sketch, it is senseless to prepare an elaborate detail drawing. Even pencilled drawings can now be adequately reproduced to meet most exacting requirements, so the necessity for inking drawings is rare. Excellent free-hand sketches can be made using blue line cross-section ruled paper as a guide.

We asked proponents of simplified drafting a number of questions. The questions and their replies follow:

What savings can be effected by use of simplified drafting methods?

Experience by a number of companies has shown a minimum saving of 35 per cent and a maximum as high as 45 to 50 per cent.

What have been the objections to simplified drafting?

Biggest objection has come from draftsmen themselves with considerable objection from manufacturing. However, where draftsmen and manufacturing personnel have been brought in on initial discussion of the virtues of simplified drafting, there has usually been no problem.

Are there advantages of simplified drafting to the manufacturing department?

It is generally easier to read simplified drawings and simpler to work with such drawings because of the elimination of complicating detail. Nothing distracts from the clarity.

What have been the problems with vendors?

Very few. The companies' drafting standards and symbols must always be explained to vendors, and there is no greater problem in explaining the simplified drafting standards. Some vendors appreciate simplification in detail.

Why doesn't the military buy the idea of simplified drafting?

Primarily because there are no over-all standards for simplified drafting and everyone connected with the military must be able to read the drawings. Since there are multiple vendors, all vendors must be able to read the drawings. Yet, some military contracts allow for certain methods of drafting simplification.

Who is working on standardization of simplified drafting?

The A. S. A. has a subcommittee, the Society of Automotive Engineers, the Aircraft Industries Association, and the British and Canadian Standards Association are notable examples.

Doesn't simplified drafting breed sloppiness in drafting?

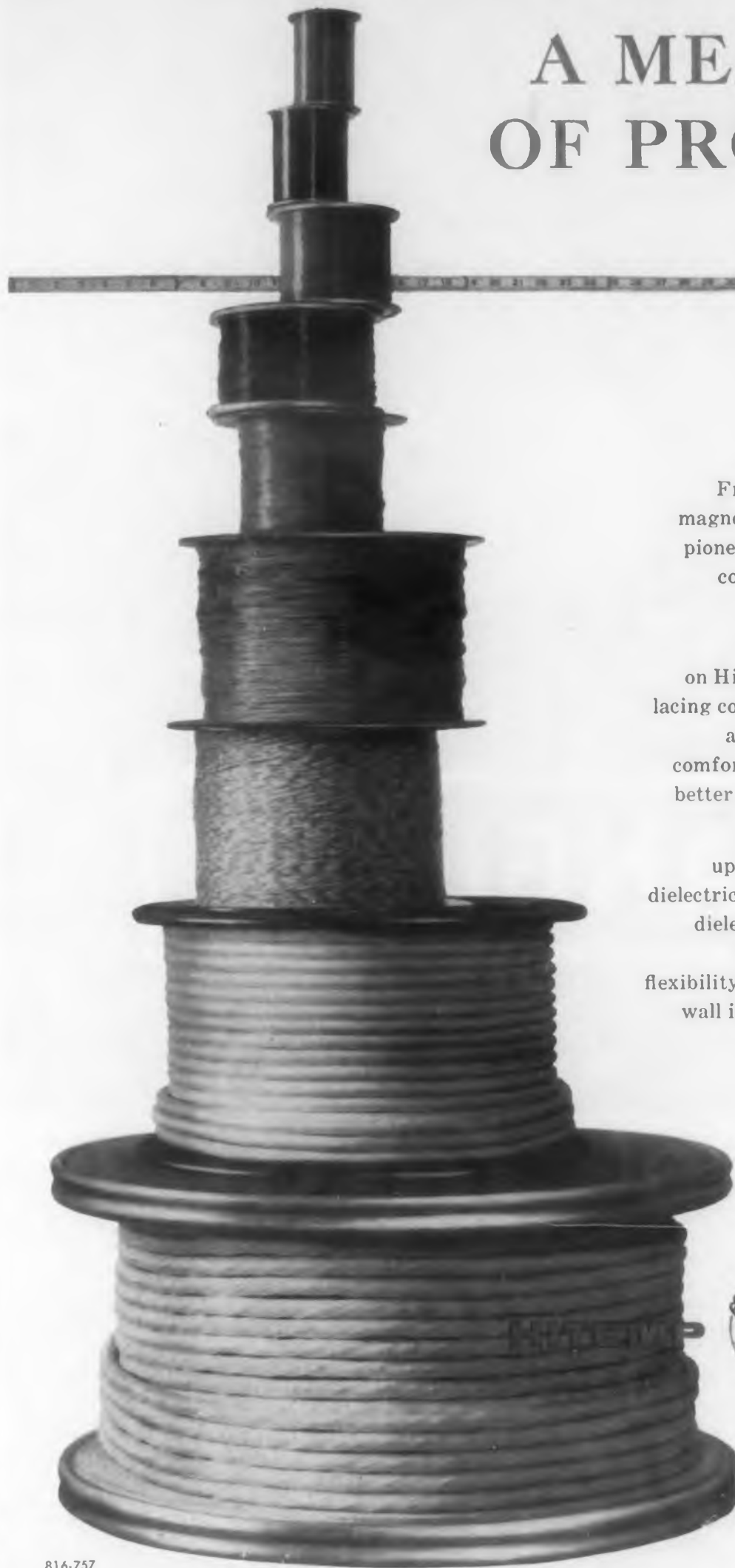
There is no excuse for sloppiness. This is a question of proper supervision in the drafting room. Draftsmen are paid to convey information and not to be artists. The checker has the duty to insist that important information be shown.

How does simplified drafting affect problems of drafting checking?

With simplified drafting the checker must be more on his toes. He cannot make assumptions. He must check everything out. The chances are the drawings will be more accurately checked when simplified drafting is employed.

J. H. Bergen of American Machine and Foundry Company at Stamford, Connecticut, quotes some astonishing figures. Mr. Bergen sug-

A MEASURE OF PROGRESS



From one item—Teflon[®] insulated magnet wire—Hitemp Wires, Inc. has pioneered an immense variety of both commercially standard and highly specialized products.

Today, manufacturers who rely on Hitemp's full line of wires, tubing, lacing cord, tape, cables, cable assemblies and even marking fluid, enjoy the comfortable feeling of knowing that no better...no more reliable source exists.

Whether your problem is heat, up to +500° F., of cold to -130° F.; dielectric characteristics (low loss factor, dielectric strength or high insulation resistance); chemical inertness; flexibility; resistance to moisture; or thin wall insulation...design your product, improve it and protect it with Hitemp wires and cables.



WIRES, INC.

1200 SHAMES DRIVE
WESTBURY, NEW YORK

816-757

CIRCLE 31 ON READER-SERVICE CARD

RECTANGULAR

CATHODE-RAY TUBES

Save valuable panel space by using Du Mont Rectangular Cathode-ray Tubes. These tubes permit a larger usable screen area in a given space by elimination of seldom-used segments of the circular screen.

Du Mont Rectangular Cathode-ray Tubes are available in electrostatic or electromagnetic types, in a wide range of screen sizes, shapes and materials. Write for complete technical details . . .



Rectangular screen for display of single, or superimposed patterns.



Square screen for display of two signals on a single time base.

	Tube Type	Screen Size	Focus	Deflection	Max. Anode Voltage	Length
DU MONT RECTANGULAR CATHODE-RAY TUBES	B1204	4" x 2"	Electrostatic	Electrostatic	6 KV	17"
	K1206	3½" x 3½"	Electrostatic	Electrostatic	6 KV	12"
	B1167	6" x 7½"	Electrostatic	Electromagnetic	12 KV	10"
	B1194	3" x 1½"	Electrostatic	Electromagnetic	16 KV	10½"
	K1442	6½" x 6½"	Electrostatic	Electromagnetic	35 KV	12¾"

INDUSTRIAL TUBE SALES, ALLEN B. DU MONT LABORATORIES, INC., 2 MAIN AVENUE, PASSAIC, NEW JERSEY

CIRCLE 32 ON READER-SERVICE CARD

gests that some 400,000,000 hours of drafting time a year can be saved by employing simplified drafting. At three dollars an hour this is a yearly saving of over a billion dollars in drafting alone.

Cons and Pros

Not only is a lack of standards on simplified drafting a problem which confronts the user of such techniques, but there are other problems as well. Some of these have been expressed by Rowen Glie of W. L. Maxson Corporation in writing for the magazine of Standards Engineers Society early this year. Although he states that on very simple parts the time saved was 50 per cent when simplified drafting methods were employed and 35 per cent on more complicated parts, it was impossible to do a complicated casting using free-hand sketching. Another handicap he noted with free-hand sketching is lightness of line which made repeated reproductions impossible. From Glie's studies he concludes the following:

- With free-hand sketching the advantage of re-evaluation of the merit of the design that normally accompanies detailing is lost. Free-hand sketches have a great "error probability." They reproduce poorly and their life is short.
- Too much reliance must be placed on the draftsman's ability to concentrate, visualize, and to record correctly the information from the layout to the drawing.
- Draftsmen must be trained to do free-hand sketches, but even with adequate training not all draftsmen will be good free-hand artists. Cross-sectioned underlay will help but will slow up drafting.
- Free-hand sketching has its place. It could be used on parts of very simple outline, on parts having very few dimension lines, on block diagrams and schematics, on outline drawings where the main purpose is to show mounting small assemblies.

But Mr. Glie includes a number of points

which will help reduce drafting costs. They are:

1. Provide the mechanics for a steady flow of information by creating project and design specifications for each job.
2. Make it mandatory for engineers to present their communications on some kind of reproducible company format.
3. Make it mandatory for designers to mark up their layouts with all significant data for draftsmen.
4. Establish shop practice specifications.
5. Eliminate drafting of parts in general use by creating drawings of standard and common parts.
6. Create a file of purchased drawings and means for their control.
7. Codify the simplest method of drafting described in JAN-STD-1.
8. Select and codify in the drafting manual, the simplified drawing practices which are acceptable to your company. The drafting practices of American Machine and Foundry, General Electric, or International Harvester can be the basis for your own simplified drafting.
9. Simplify drawing change procedures.
10. Study the possibility of making details on the same sheet as the assembly.
11. Put the list of parts on the same sheet as the assembly whenever possible.
12. Study the use of the photographic camera as a means of recording breadboard assemblies, harnesses, and piping.
13. Recommend wider use of wash-off tracing cloth when only portions of an assembly must be changed in order to use it as a new assembly on another project.
14. Provide draftsmen with adequate tools and working conditions.
15. Control time and cost by making the draftsman keep a record of time spent by him on each drawing. This will give realistic time and cost estimates and will keep the draftsmen under control.
16. Create a cost and time-conscious atmosphere in all departments, by organization of cost control as a primary objective. If so done, benefit will accrue from simplified drafting practices and increase the efficiency in drafting.

What To Do

Analyze simplified drafting techniques in light of the type of design job which your company has to do.

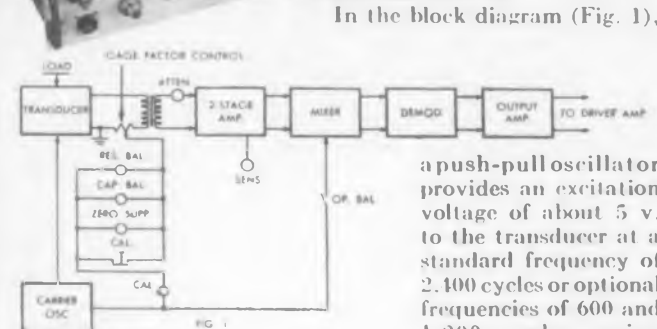
Based on such an analysis decide which simplified drafting practices can save time and money for you. Establish these as a standard within your own company until such time as national standards are devised, and you will save money in the meantime.

TECHNIQUES and DEVELOPMENTS in oscillographic recording

FROM
SANBORN

CIRCUIT DESIGN AND TYPICAL USES OF THE "150" CARRIER PREAMPLIFIER

One of the most frequently used plug-in front ends for Sanborn 150 Series oscillographic recording systems is the Model 150-1100 Carrier Preamplifier, since with it a "150" system can record such variables as force, temperature, strain, pressure, displacement, velocity, flow, acceleration — or any variable which can be expressed as a suitable input signal by a transducer. The "1100 Carrier" will operate with a variety of different transducers and bridge circuits, which will be mentioned later on.



This excitation voltage also feeds the Balancing, Calibration and Zero Suppression circuits. (The Balancing controls allow correction of resistive and reactive signal leakage from the

transducer, so that at zero load the net signal to the Pre-amplifier is zero. The Zero Suppression feature permits bucking out a large static load so that a small part of the load can be expanded over the full recording chart. The Gage Factor control allows the zero suppression range to be made equivalent to some convenient transducer load, or the full load rating of the transducer, and also causes the calibration signal to represent 2% of that load.) Transducer output is fed to the transformer through the Gage Factor potentiometer, across which the Balancing-Calibration-Zero Suppression circuits develop a voltage effectively in series with the transducer output. The mixer receives a suppressed carrier AM signal and re-inserts a carrier component, to make its output a conventional AM signal whose modulation represents the transducer load. The modulation signal (whose amplitude and polarity represent magnitude and direction of transducer output) is recovered by the demodulator and fed to the output amplifier, which in turn excites the Driver Amplifier and recording galvanometer of a "150" system.

Transducers which may be used with the Carrier Preamplifier include strain gage half-bridges or full-bridges, commercial resistance or reactance bridges, differential transformers and resistance thermometer bridges. The transducer chosen should provide at least 18.0 microvolts per volt of excitation at the minimum load to be recorded, for a one cm. deflection; impedance should be 100 to 1000 ohms. With strain gages, normal operation provides sensitivities of 50, 20 or 10 micro-inches per inch for each cm. on the recording, depending on the number of active gages. With resistance thermometers, if 1°C. or 2°F. per cm. stylus deflection is sufficient sensitivity, the user can construct his own resistance thermometer by including a 3 ohm coil of copper wire in one arm of an equal arm 100 ohm bridge.

Helpful information about the use of transducers with the 150-1100 Preamplifier is contained in the following Sanborn RIGHT ANGLE articles (reprints on request): Coupling Differential Transformers, Aug. and Nov. 1956; Filter Networks for use with Force Dynamometers, Nov. 1956; Calibration with 1-, 2- or 4-arm Strain Gage Bridges, Aug. 1955; Theoretical and Actual Applications of Bridge Circuits, May and Aug. 1954.

Wing flutter recording to infrared research . . .

with the versatile "1100 Carrier"

Today, Carrier Preamp-equipped Sanborn "150" systems are being used for frequency response tests of process control system components; to record shaft deflections of fluid mixing equipment; in infrared research . . . vehicular traffic studies . . . submarine hull vibration measurements. Applications are limited only by the transducers available.

These are applications of only one "150" front-end, eleven more interchangeable, plug-in Preamplifiers increase the scope of Sanborn oscillographic recording systems to meet an almost infinite variety of research, production and field testing requirements. All Sanborn "150" direct writing systems record inkless traces in true rectangular coordinates; all provide 1% linearity; Basic Assemblies — equipped with your choice of Preamps — are available from one- to eight-channels, packaged in vertical cabinets, portable cases, or specially modified housings.

Technical data and help with your oscillographic recording problem are always available from Sanborn.

SANBORN COMPANY
INDUSTRIAL DIVISION

175 Wyman St., Waltham 54, Mass.

CIRCLE 33 ON READER-SERVICE CARD



When it has to be heated rely on Safeway Woven Heat Elements

... and the "it" can be just about anything from a simple tray to the curing blankets for honeycomb structures.

Safeway Woven Heat Elements are custom tailored to fit specialized requirements of many applications. A single aircraft, for example, may need upwards of 80 different heating and de-icing elements, all of which are made by Safeway. Other applications are on helicopter rotors, rocket tubes, missile launchers, and on a wide variety of molds, dies, tanks, ovens and dryers in industry.

If you have a problem that requires heat, let Safeway engineers study your requirements and—without obligation to you—submit an appropriate recommendation.

*For your copy
of a fact-filled folder,
write to:*

Safeway

**HEAT
ELEMENTS
INC.**

680 Newfield Street • Middletown, Connecticut
CIRCLE 34 ON READER-SERVICE CARD

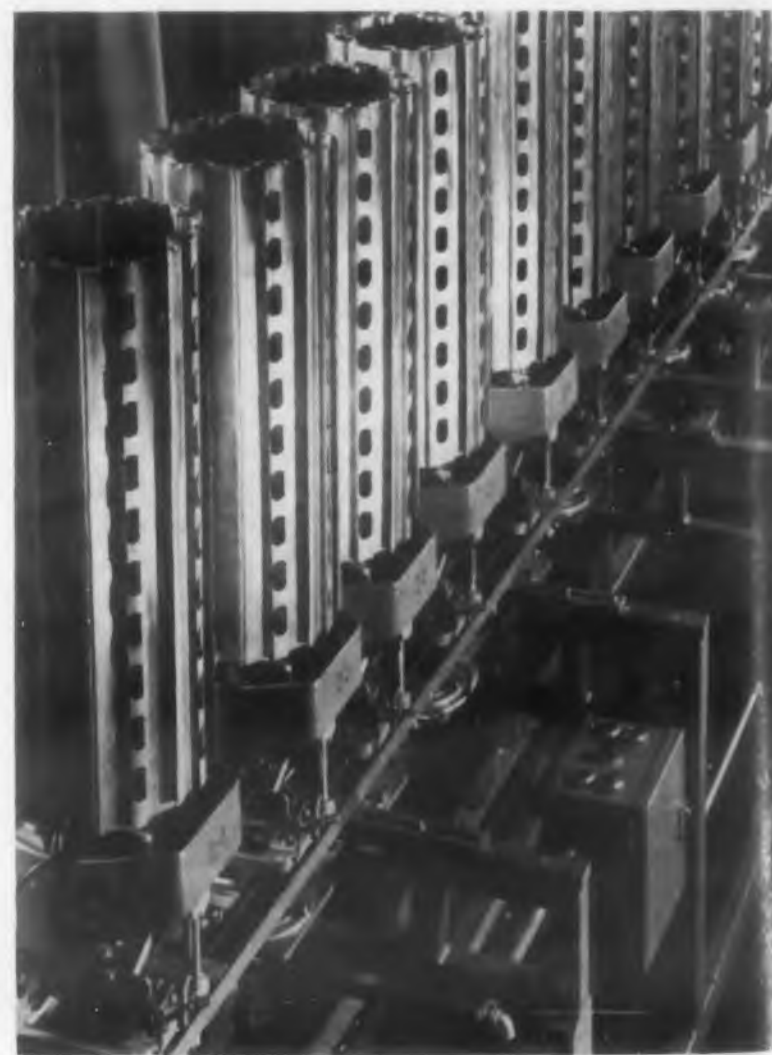


Design for **LOW-COST PRODUCTION**

4 Standardization

PROBABLY no single item is more significant in keeping production costs at a minimum than standardization, in its broad sense. Most companies interviewed stressed standardization of components, elimination of as many specials as possible, and component interchangeability, as prime cost saving ingredients.

Although most companies appear to have some form of component standardization program in effect, few companies insist that the design engineer follow the standards. Several companies stated that they now require the designer to justify why he can not use a standard part



"Standard" component assembly machinery built by General Mills, Inc.

listed in the standard parts book. Some companies do not go this far.

In one company over a third of all parts that ever had been employed in electronic equipment were listed in the standards book as standard for that company. Few of these parts were stocked, either by the company or its vendors; thus the standard-parts book was of questionable value in keeping costs down. Standardization should depend upon frequency of component usage, whether savings can be had by stocking an item, whether vendors carry an item in stock, or whether the time cycle from design-to-production can be cut thereby.

Self-discipline Required

It is quite simple to establish standards for mechanical parts. A few sizes of machine screws, nuts, washers, spacers, chassis bases and even cabinets should serve to meet a bulk of the requirements in most equipment manufacture. The feeling on the part of each engineer that he must create a completely new design different from any that has been prepared by his company before appears to be primarily responsible for the large number of different sizes of components employed, as well as different shapes and designs. Such multiplicity is expensive and often cannot be justified purely on the basis of function which is to be performed by the equipment.

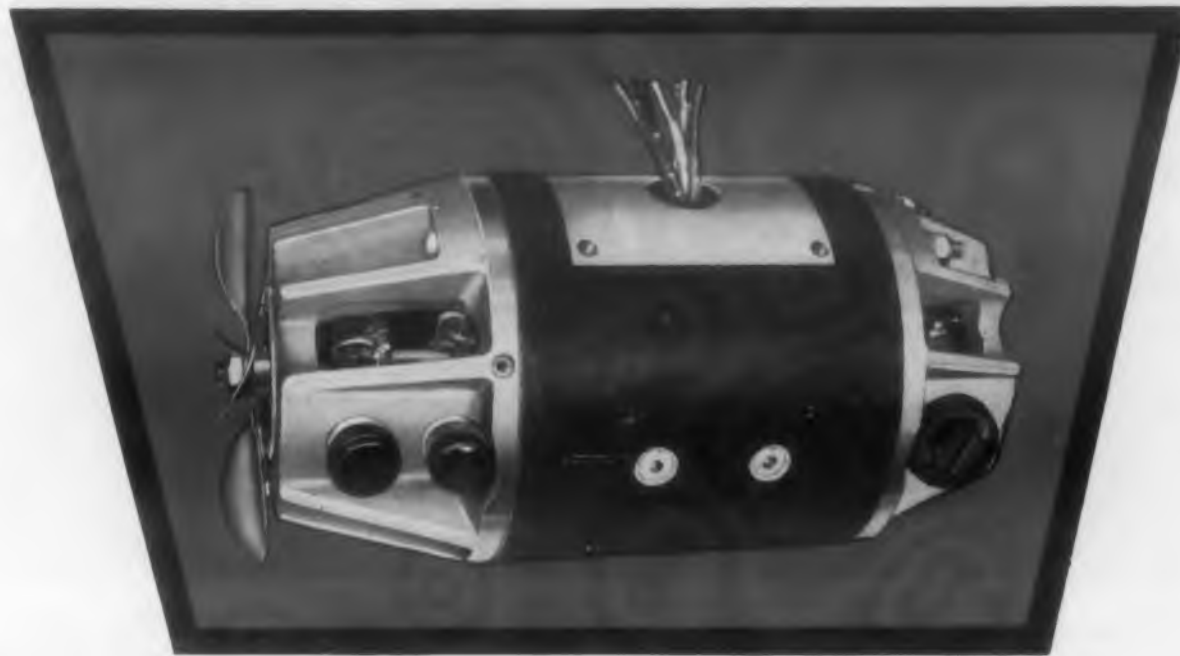
Careful analysis by one small manufacturer of diversified electronic equipment showed that labor costs for fabricating its products were essentially insignificant in comparison to costs of components, all of which were purchased on the outside. A multiplicity of parts was required, so they decided to standardize wherever possible. By purchasing enmasse, high volume discounts could be obtained. But to purchase enmasse required purchasing for more than one equipment at a time and sometimes for more than one production run of their entire line. Standardization was the answer. Wherever possible they selected standard replacement parts handled by radio jobbers. There are produced in large quantities and are available at low cost to manufacturers.

In addition, as many parts as possible were eliminated from the designs. Interchangeability was engineered into the various diversified products to make possible the use of the same component in a number of different designs. High quality components are often found in the cheapest designs of this company, because, by ordering enmasse the higher quality components needed for the expensive designs, costs can be saved overall. The same thinking went into the purchase of hardware as for electrical components.

Don't go blindly into printed wiring. One company found it cheaper to buy standard parts en-

Case History from the files of the Wincharger Corporation

problem: PROVIDE FAULTLESS POWER TO GUIDE A FAMOUS MISSILE



All the engineering ingenuity built into a famous missile was threatened by a reliability problem in the guidance power supply.

Acceleration and vibration had produced shock that "unsettled" electronic components on which the missile relied for zeroing unerringly onto the target. Wincharger's Research and Engineering Group, well-known in the industry for problem-solving resourcefulness, was asked to tackle the power supply problem.

After extensive experimentation the answer came through re-design of a single sub-assembly, providing a new and heavier shaft, larger bearings, and strengthening of the end brackets.

This missile has since gone into production, to make headline news across the world, with the required FAULTLESS power provided to guide its flight.

If your work requires special purpose power supplies, alternators, inverters, or dynamotors, bring your problem to Wincharger's Research and Development Group. Their extensive experience in solving problems in all phases of these fields is your best assurance of a workable solution.

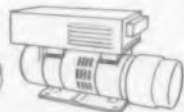
SPECIALISTS IN ELECTRONIC AND ROTARY ELECTRICAL DESIGN AND MANUFACTURE

WINCHARGER CORPORATION

DEPT. ED-117, SIOUX CITY, IOWA



ALTERNATORS



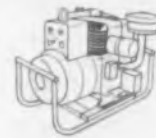
INVERTERS



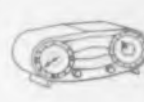
DYNAMOTORS



UNIVERSAL MOTORS



ENGINE-GENERATORS



RADIOS

CIRCLE 35 ON READER-SERVICE CARD

WINCE[®] CONVERTER BY
WINCHARGER

Specifications

Input — Nominal 26.5 volts D.C.

Output No. 1 — 135 volts D.C. at 400 mils with 20 ohm choke

Output No. 2 — 280 volts D.C. at 150 mils without choke

Unfiltered Ripple Maximum — 10%

Duty — Continuous

Temperature Range — Minus 65° C to plus 125° C
Note: Must operate for 6 minutes at 246° C

R.P.M. — 6,000

Altitude — 80,000 feet

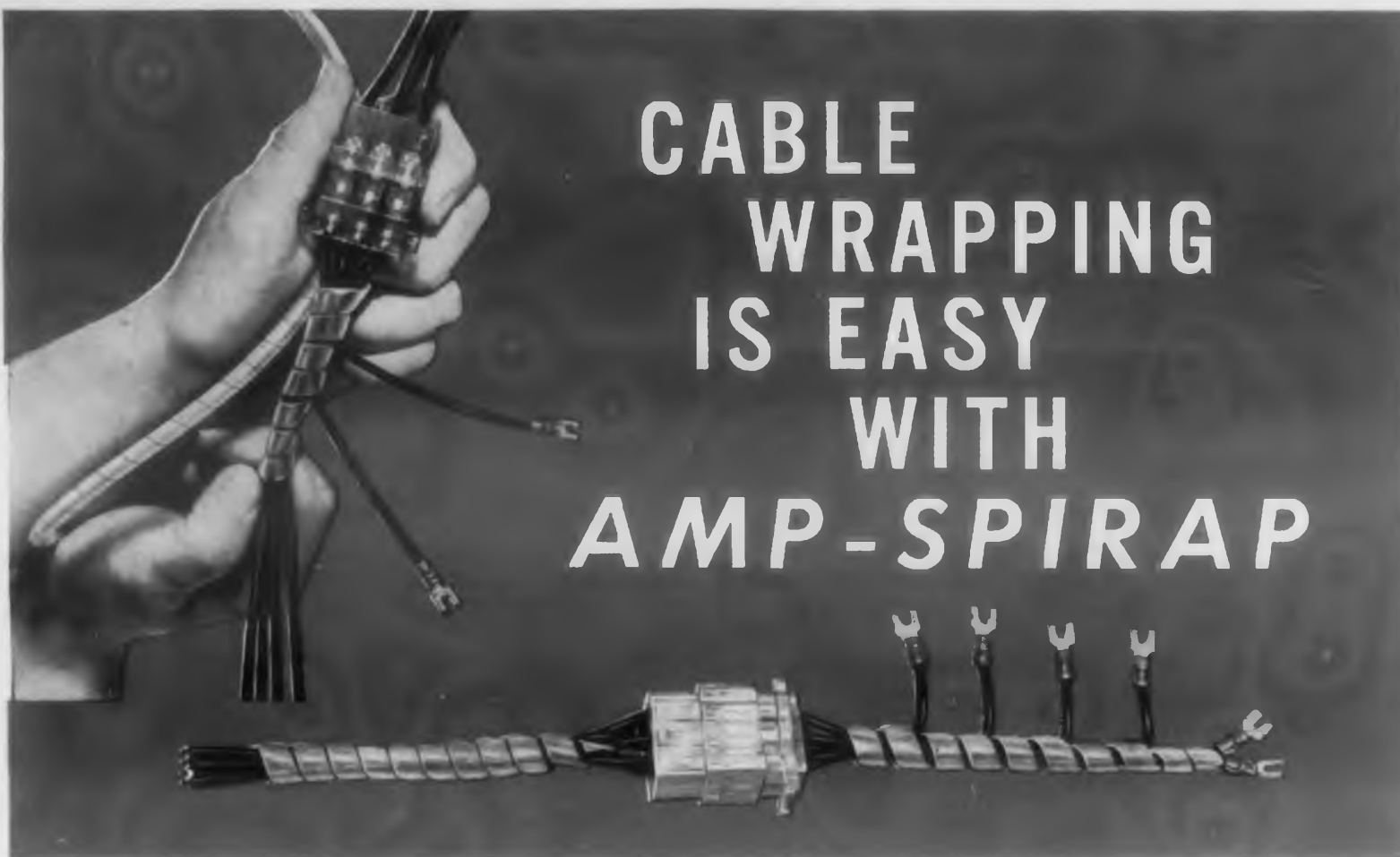
Meets all requirements military specifications

MIL - D-24A

Subsidiary of

ZENITH

Radio Corporation



CABLE WRAPPING IS EASY WITH AMP-SPIRAP

The development and production of the finest quality solderless terminals for your electrical circuitry requirements is AMP's primary objective. We also constantly search for allied products and application techniques that will speed, simplify, and obsolete present time-consuming sub-assembly operations. AMP-SPIRAP and its application technique stems from such constant searching activity.

AMP-SPIRAP is a unique, spirally-cut plastic wrapping that . . .

- eliminates tedious cable lacing, insulation damage, and pulling of wires through spaghetti tubing
- is quickly applied to wire bundles of any size up to 3 1/2 inches diameter
- permits individual wires to be entered or led out at any point
- is quickly unwound to allow wires to be added, removed, or relocated—thereby eliminating the necessity for cutting into the cable bundle after assembly
- holds wires together tightly, but permits flexibility for forming cable
- provides mechanical protection over entire length of cable

When required for your maintenance and repair needs, AMP-SPIRAP is available in the U.S.A. through American Pamcor Inc.

api
AMERICAN PAMCOR INC.

Additional information about AMP-SPIRAP and its application versatility is available on request. **SEND FOR YOUR FREE SAMPLE TODAY.**

AMP INCORPORATED

GENERAL OFFICES:

3532 Eisenhower Boulevard, Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada
Aircraft-Marine Products (Great Britain) Ltd., London, England • Societe AMP de France,
Le Pre St. Gervais, Seine, France • AMP—Holland N.V. 's-Hertogenbosch, Holland

Distributor in Japan: Oriental Terminal Products Co., Ltd., Tokyo, Japan

CIRCLE 36 ON READER-SERVICE CARD

Design for LOW-COST PRODUCTION

4

masse and use conventional wiring methods. Transistors are not used, because tubes are cheaper in quantity and are readily available for replacement at low cost.

The only place where this company does not standardize is in equipment housing. From a purely marketing standpoint they have decided to spend money here. Their cabinets are all special, are available in multiple colors, and are designed with human engineering considerations in mind. But, it must be remembered that adding cost at this point is not always justified. It depends upon the function which is to be served. In this case, paying to get appearance appeared justified in order to produce sales. Military equipment is generally "sold" before it is built, and this factor is unimportant.

Keep these points in mind:

- Save cost by eliminating all possible components or parts, and standardize on a few simple and readily obtainable ones which can be purchased enmasse. If possible, stock these for future use.
- Buy standard equipment, particularly hardware, on a "min-max" basis. Suitable items of this nature are screws, nuts, rivets, eyelets, etc. Many such items are machine fed in assembly, and equipment is on hand in the production shop for installing them at a rapid rate. The important thing here is that engineers know and specify the min-max items wherever possible.

Metal work standardization. For appearance design, it is often desirable to go to costly tooling operations such as for the fabrication of die-cast panels, etc. When this is done, such die castings should be developed with interchangeability in mind between various equipments that the company manufactures. One company making oscilloscopes has two standard sizes of die-cast panels. The designer is obligated to make his "gear" fit the panels rather than design new panels to fit his gear. Cabinet framework can be adjusted in size to accommodate a particular equipment by using standard stock extrusions for frame-pieces. These extrusions are available from vendors in certain standard lengths.

Longest lead time is generally required when buying die or sand castings, transformers, plastic moldings, or extrusions. By standardizing on these items and stocking basic units, design-to-production time can be reduced.



One company has a basic plastic mold for dials. These dials are stocked without lettering. They are then silk-screened according to new designs, which takes only a few days. Various colors can be obtained in the dials from the vendor without additional cost since colored molding powder is readily available.

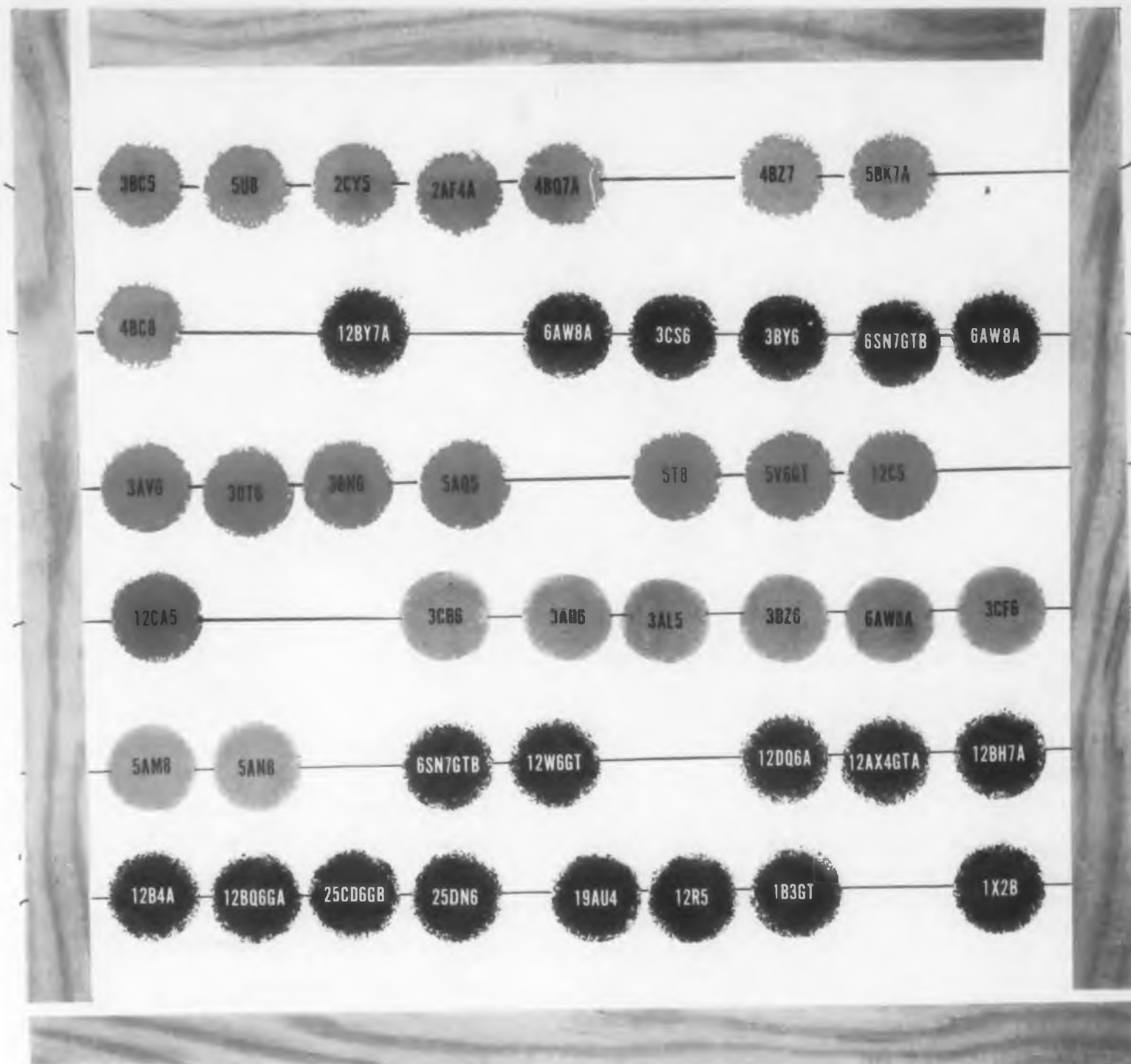
Another trick to save costs would be to keep the depth or width of all instruments the same, allowing only one dimension to vary. This allows sheet metal stock to be obtained and stocked in standard width, avoiding or minimizing scrap.

Standardization by supplier. On some items, which cannot be stocked in large quantity because of the impossibility of interchangeability or because of low-volume production, costs can sometimes be saved by picking a single supplier for all components of a type. This, however, must be watched carefully since the market changes daily. New vendors often prove superior from a delivery and cost standpoint as well as quality.

A few standardization tips:

- Try to center non-critical components into specific standards values;
- Stock standard hardware items on a min-max basis;
- Stock much-used electrical items such as resistors and capacitors on a min-max basis;
- Try to fit a standard part into your design before considering a "special";
- Try to avoid use of "specials" in mechanical assembly, since tooling is often costly;
- Design to use standard punches and dies. Check with vendors for their stock dies when in question;
- Don't design special holes and louvers without checking on standard hole and louver dies available;
- Take into account machines available in your plant or in the hands of vendors, before specifying processes;
- Design for minimum operations in fabrication or assembly;
- Know your available suppliers, their facilities, and their available tooling. Designing around this can save you money.

Probably more effort is going into establishing standards than ever before. Until industry wide standards are available, however, the best approach to cutting costs by standardization is to get complete agreement on standards within ones own company. Where this consists of a number of divisions, getting purchasing agreements among all divisions or plants of a company will help reduce costs. Industry-wide standards can effect big savings, and companies should accept such standards at once when established. More electrical components should be standard in the same manner as nuts and bolts.



ANYWAY YOU ADD IT...IT'S TUNG-SOL FOR SERIES-STRING TV TUBES

Advanced designs in heater and cathode structures, which made possible *controlled warm-up time*, established Tung-Sol as the *pioneer producer* of 600 ma series-string heater tubes for TV

Tung-Sol, while continuing to add to this select circle of most widely used 600 ma types, further expanded its series-string line to include 450 and 300 ma tubes for sets requiring fewer tubes.

At present Tung-Sol supplies a complement of nearly 200 of these tubes to the initial equipment manufacturers and the replacement field . . . a

solid indication not only of the success of the series-string principle, but also of Tung-Sol's unfailing ability to meet the strictest performance requirements and production schedules.



TUNG-SOL®

ELECTRON TUBES • SEMICONDUCTORS

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

CIRCLE 37 ON READER-SERVICE CARD



5 Selecting Materials and Components for Low-Cost Production

ONE OF THE most likely places to squeeze costs out of a design is at the outset when materials and components are selected. This is particularly true when mass production is contemplated.

Materials

The design engineer has several alternatives open to him to assure that his design will employ the material which results in lowest cost for the function to be served. He may be a materials expert himself, he may have a materials expert available whose knowledge can be tapped on call, or he may have close liaison with outside vendors who will provide the necessary consulting service. But, in any event, the increasing importance that must be attached to proper materials selection cannot be overemphasized. As one writer recently put it, "In today's missile industry, not only are environment, humidity, sub-zero temperatures, and storage demands far greater than history has heretofore known, but the electronic operational characteristics, heat transfer, space saving and packaging of electronic components, and intricate mechanical precision and microwave fits also make uncommon demands (on materials) . . . A close-knit association between designers and metallurgical research efforts (are necessary to assure development and selection of the right material at lowest cost for a given application.)"

Components

One large company interviewed pointed up an important fact—"cost begins with the part."

To keep costs down, selection of vendors is important. Low cost of end product does not neces-



Typical components designed for ease of assembly. Good electrical contact is made through compression fits without soldering. Special, but relatively simple, machines "do the work" rapidly and at a minimum of labor cost. Courtesy, Burndy Corporation.

Component Engineering Data Sheet

Name _____	Company _____	Date _____	
Type component:	Resistor <input type="checkbox"/>	Capacitor <input type="checkbox"/>	Other <input type="checkbox"/>
Application:	Radio <input type="checkbox"/>	Television <input type="checkbox"/>	Industrial Electronics <input type="checkbox"/>
	Other <input type="checkbox"/>	_____ Explain _____	
Frequency of circuit operation: _____			
Component size requirements (if any): _____			
Lead arrangement desired _____			<input type="checkbox"/> Essential
(show sketch if necessary)			<input type="checkbox"/> Preferred
Operating Temperature Range _____ deg C			
Samples required <input type="checkbox"/> Yes		How many? _____	
<input type="checkbox"/> No			

Place Circuit Sketch Here

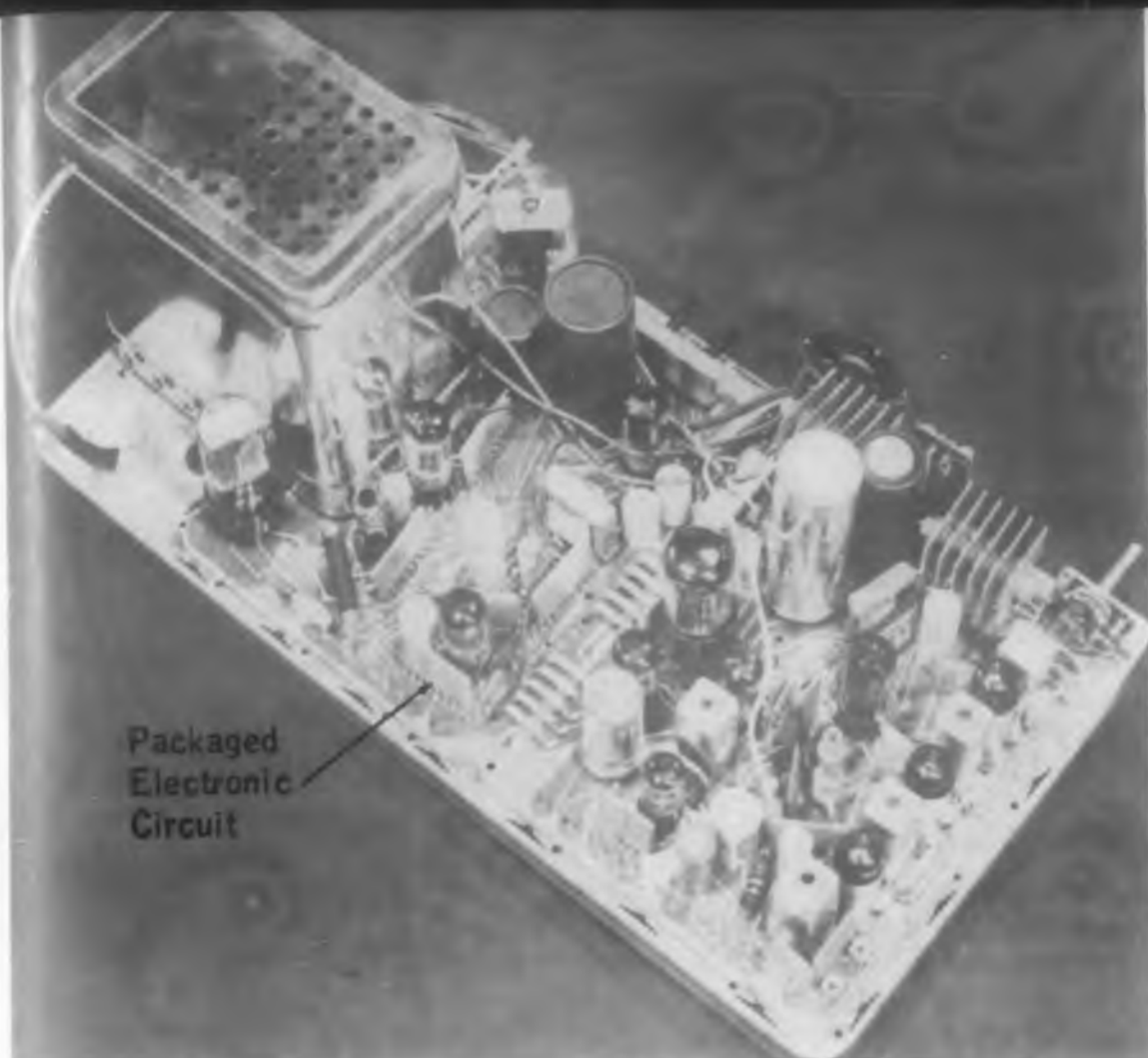
Values and Tolerances*

R1 _____ ± _____ %	R5 _____ ± _____ %
C1 _____ ± _____ %	C5 _____ ± _____ %
R2 _____ ± _____ %	R6 _____ ± _____ %
C2 _____ ± _____ %	C6 _____ ± _____ %
R3 _____ ± _____ %	R7 _____ ± _____ %
C3 _____ ± _____ %	C7 _____ ± _____ %
R4 _____ ± _____ %	R8 _____ ± _____ %
C4 _____ ± _____ %	C8 _____ ± _____ %

*Note:

1. Mark with a (D) resistors sensitive to distributed capacity.
2. Show voltage rating alongside resistors where more than 1/5 w.
3. For capacitors, is temperature compensation required? yes no
4. For capacitors: Voltage rating _____ v dc
ac

Information for Data Sheet courtesy of Centralab, Milwaukee, Wis.



This television chassis combines plated circuit boards with packaged electronic circuits. The new concept decreases chassis area 20 per cent; combines 97 separate parts into 17 group units. The chassis is Motorola's; the packaged circuits are Centralab's.

sarily mean lowest cost vendor. A vendor who furnishes consistently reliable components falling within the agreed-on limits of tolerances and quality, and who will accept defective returns, may prove to be the best vendor to keep end-costs down even though his cost may be slightly greater than the lowest bidder.

Many companies have found that establishment of a component group as a special service to designers, for the purpose of testing components and serving as a liaison with design on standards and components selection, has not only improved reliability of end equipment but reduced cost.

If equipment is to be fabricated by automatic assembly techniques, tolerances on physical size of components, quality of leads, etc. is very important. In some cases, a higher-cost component results in less cost on the assembly line and less down time of the automatic assembly equipment. Watch these factors carefully.

Also, for automatic assembly use of modules can often save cost. For example, in the illustration shown, a leading television manufacturer reduced costs of its

110 deg. picture tube portable by using modules that contained components for several stages in one package. The module cost was less than the combined cost of components, and labor was saved in installing the units. Note the neater appearance of the chassis when using these modules. Trouble shooting is usually isolated to a particular module, which also saves time.

As mentioned previously, every attempt should be made to standardize on a limited number of components, as this can have great effect in saving costs as well as improving delivery time, reducing prototype to production time, etc.

The vendors can also help designers select the right component for a specific job. However, to do so usually requires furnishing complete circuit and use specifications to the vendor's design department. The accompanying specification sheet is an example of the kind of information which designers should furnish vendors. It was prepared by a leading component vendor, which if properly filled out by the user, will help the vendor suggest the proper component—in this case a resistor or a capacitor.



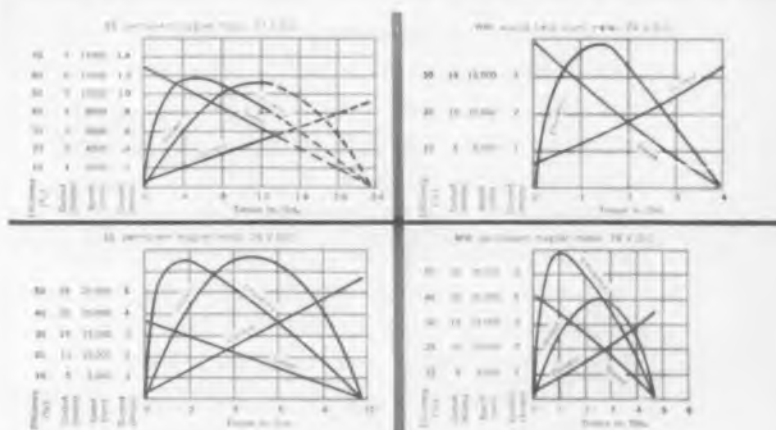
KEY SOURCE FOR SMALL MOTORS

Globe Industries should be your prime source for small, peak performance A.C. and D.C. motors for fundamental reasons. For instance, the four D.C. motors shown are just a beginning—not only can you have them in countless variations, but you can add scores of standard spur or planetary gear ratios. Also, a wide variety of governors, clutches, brakes and filters are available promptly to meet any need you have. All these variables are combined by Globe to give you a motor which outperforms any other motor of comparable size.

An interchangeable standard part inventory, coupled with precision production techniques to match engineering efficiency are specific reasons why you can obtain quality custom built prototypes in 2 to 4 weeks. These same methods shorten lead time on Globe actuators, timers, rate gyros, blowers, servos.

Ask the largest D.C. miniature motor manufacturer first.

Send for your copy of the Globe D.C. motor catalog now.
GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio, HE 3741



STANDARD CHOICES: voltages to 120 V.D.C., output to 1/20 h.p., 129 spur and planetary gear ratios, geared break away torques to 2500 oz.in., many varieties of governors, clutches, brakes, and filters are available. The graphs appearing above illustrate typical performances.

CIRCLE 39 ON READER-SERVICE CARD



Design for **LOW-COST PRODUCTION**

Labor Savings

6

with

Printed Wiring



Programmed automatic component insertion machine. This new printed wiring board component insertion machine has only two insertion heads, but can select for insertion at any given instant any one of a large number of components available on tape reels. Programming for the assembly is determined by I. B. M. punch cards inserted in the programming unit. One component is inserted at a time, but once the printed circuit board is placed in position in the machine, all components are inserted in the board without further attention from the operator. This machine, developed by International Business Machines Corp., is applicable to low and medium production quantities and has the advantage of high production efficiency. The machine can insert standard 1/2 and 1 w resistors and similarly sized capacitors and diodes.



A component inserting machine (Dynasert No. 3) for mechanical assembly of a wide range of axial-lead components to printed wiring boards. The machine cuts component leads, forms them into a staple shape, inserts them into holes in the boards, and clinches them in the desired direction in one operation. Up to 600 insertions per hour can be made on an average size board. Boards from 1 in. square up to a foot or more may be processed. Axial lead components can be handled up to 1 in. in body diam, on center spacings from 1/2 to 3 in. A forty-six-page booklet is available: "Designing for Dynasert," on request to the manufacturer, United Shoe Machinery Corporation, 140 Federal Street, Boston, Mass.

PRINTED circuits, or, more explicitly, printed wiring, implies no manual wiring, but fabrication by mass processing methods. This means lower costs for high- or medium-volume production. Components can be inserted into boards by machine, and an entire subassembly is finished in a one-shot dip soldering operation. In addition to assembly time being reduced, inspection time is cut. The possibility for rejects is less because printed wiring processes produce more uniform results. Less specialized labor is required at all stages of fabrication.

Alternate methods of making printed circuits vary widely in processing costs. The print and etching process is slow and wasteful of copper. Methods of 1. molding, 2. special plating, or 3. stamping conductors are more direct and suggest dollar savings. However, for today's production problems, these differences are more apparent than real. Informed printed circuit people say 90 per cent of the dollar volume of printed wiring is done today by the etch process. The lower cost processes either are for very specialized cases only or they simply haven't proved out yet. The picture may be different next year, if the more promising processes overcome current handicaps. To date, delivery, if original specs are met, is problematical.

This is not to say there are no problems with printed-etched processes. If the production of printed wiring were cut and dry, the topic need not be included in this report. As a matter of record, several electronic equipment manufacturers have lost huge sums of money by not being able to get printed wiring boards that stood up under tough operating conditions. Lower costs are, therefore, not assured.

Most troubles have been with plated-through holes and eyelets. Rejects from these causes

seem to result mostly from lack of knowledge on the part of some suppliers. On the other hand, big users such as IBM and Arma have had no difficulties on this score. Some suppliers have made consistently good plated-through holes for several years. Extensive study on their part showed how to make reliable boards. A leading company reports that they have no reject problem whatsoever. The case for foolproof eyelets cannot be made so assuredly. Satisfactory eyelet boards can usually be delivered, but good plated-through boards offer advantages. Eyelet boards are also generally more expensive.

Lowest Costs Depend on Many Things

The type of material selected is the most important factor. Material costs usually represent one-half to two-thirds of the cost of the printed board. Costs increase with the size of the board. The complexity of the fabrication and the quantity make big differences. Tolerances specified dictate the type operation and costs. In general,



Tape-programmed automatic insertion machine. This new PW board automatic component insertion machine has provision for selecting 24 different components as determined by punched tape programming. PW boards up to a maximum size of 9 x 11 in. can be accommodated. The tape will select the operation to be performed, such as drilling or punching of holes on ± 0.003 in. hole location, or insertion of selected components. Drilling or punching of holes can be carried out on one PW board, while another is having components inserted. It is only necessary for the operator to place the boards in position and start the machine. Indexing and selection of components is automatic. Manufacturer is Design Tool Corporation, 80 Washington Street, New York, N.Y.

for over 1000 pieces a punching and die blanking operation is least expensive; for less than 1000 pieces, drilling and routing or sawing to size generally turns out to be less expensive.

Relative Material Cost

Most boards are made of laminate. Using it as a standard of comparison, melamine Fiberglas (NEMA Grade G-5) is next lowest at three times the cost of the paper base phenolics. Most popular after XXXP are the epoxy fiber glass boards, G-10. Epoxy boards are only slightly higher in cost than melamine-glass base boards (four times that of XXXP) and offer superior mechanical strength. They are not as abrasive as melamine boards. Teflon-fiber glass boards are 13 times higher in cost than paper phenolics and are not too often used. Switching plates, particularly flush commutator discs, use special composite laminates which run more expensive. For some non-critical requirements XXP is adequate and is about 10 per cent less than XXXP.

how to  keep  costs down
... profit margins up!

ALLEN Engineers will show you how you can save time and money by using standard* ALLEN Hex-socket Cap and Set Screws instead of specials.

Let's get this straight right away... if your product design **MUST** have special cap or set screws, then ALLEN's the place to come for them.

But our engineers have found, from a good many years of experience, that designs frequently call for *special* hex-socket cap and set screws that are only slightly "off-standard." These specials take longer to get, cost more.

Allen engineers can probably save *you* both time and money by working with you on ways to use *standard* Allen Hex-socket Cap and Set Screws, where specials may seem to be necessary. Just send blue prints, or good descriptions, of your product designs to our Engineering Department, or talk with your Allen Field Representative.

*ALLEN manufactures 1457 standard items

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.



CIRCLE 40 ON READER-SERVICE CARD



Design for LOW-COST PRODUCTION

6

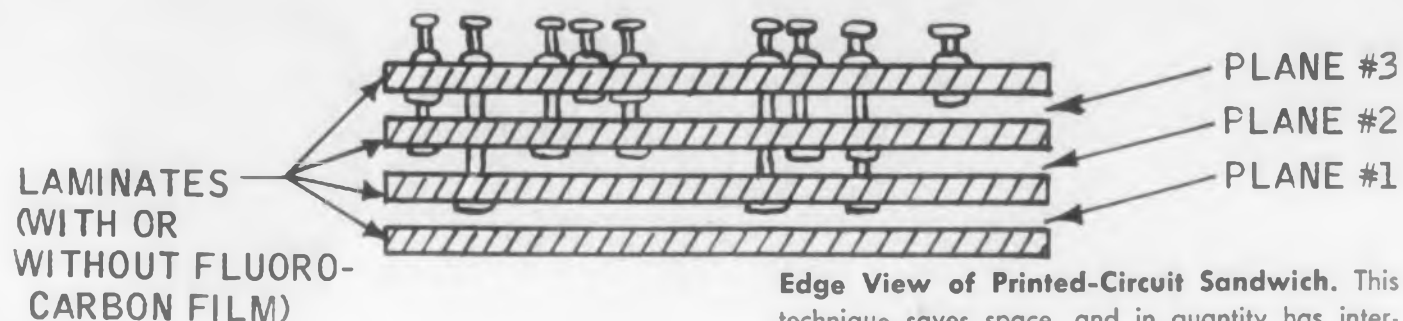
Example of Cost

The simplest board is probably an etched conductor on XXXP, no plating. Such a board might run \$0.015 a sq in. The same board solder plated, two-sided, is about \$0.05 a sq in. Plating increases costs; protective coatings add little.

As mentioned earlier, close tolerances that must be held increase costs. Premium prices are paid for holding line widths and spacing to ± 0.005 in. If hole-to-hole spacing must be held to ± 0.005 in., instead of ± 0.010 in., more expensive jig drilling is required.

Of course, designers can lower costs by following certain accepted practices in making drawings, combining small boards into one job, thinking in terms of future tooling, etc.

Since the lack of industry standards has meant designers have had few tested guides to go by, costs have often been higher than necessary. To ensure lowest cost and fast delivery consistent with good design and quality, one manufacturer publishes what it terms standard printed circuit tolerances (Photocircuits Corp., Bulletin P-9b,



Edge View of Printed-Circuit Sandwich. This technique saves space, and in quantity has interesting possibilities for production-cost reduction.

Sept. 1957). The dissemination of such information should aid in lowering production costs.

Sandwich Construction Saves Cost

According to Ralph Mondano of Raytheon's Plastics Research Group, a maximum number of electrical components such as resistors and capacitors can be positioned on the face of multiple sandwich construction. Lugs or any other type terminal suitable to the technique can be so designed to penetrate each succeeding depth to pick up the circuitry suitable to the electronic package requirement.

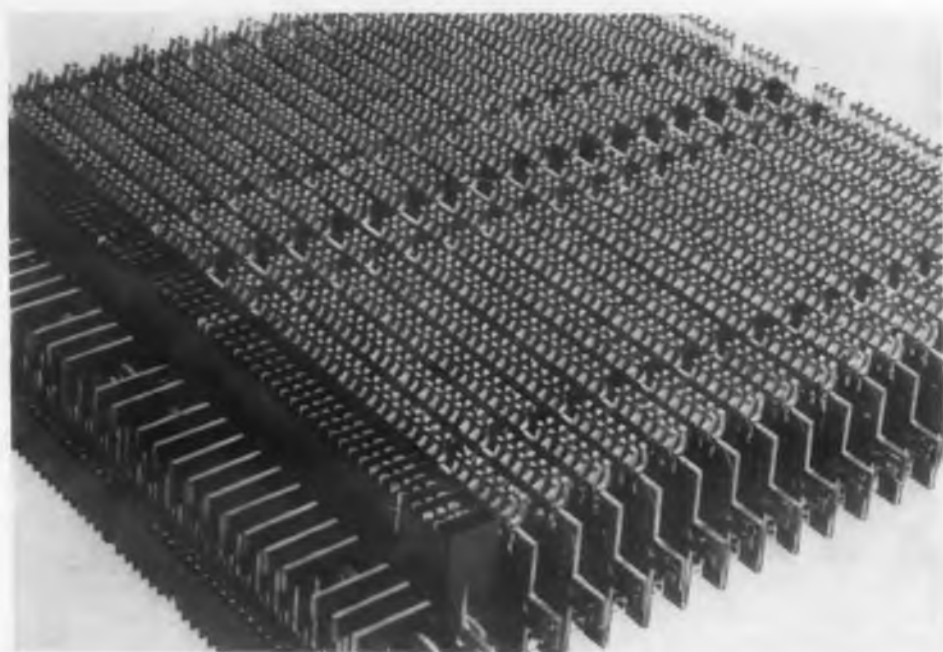
The proper geometry of each succeeding layer of circuitry can easily be laid out beforehand on a drafting board, and then checked out with the actual negatives or positives. This procedure can result in a relatively simple assembly technique. With bondable Teflon and Kel-F available, the laminate faces can have a protective layer of these good moisture-resistant polymers.

It is pointed out that there are several assembly procedures, and each one can readily be ac-

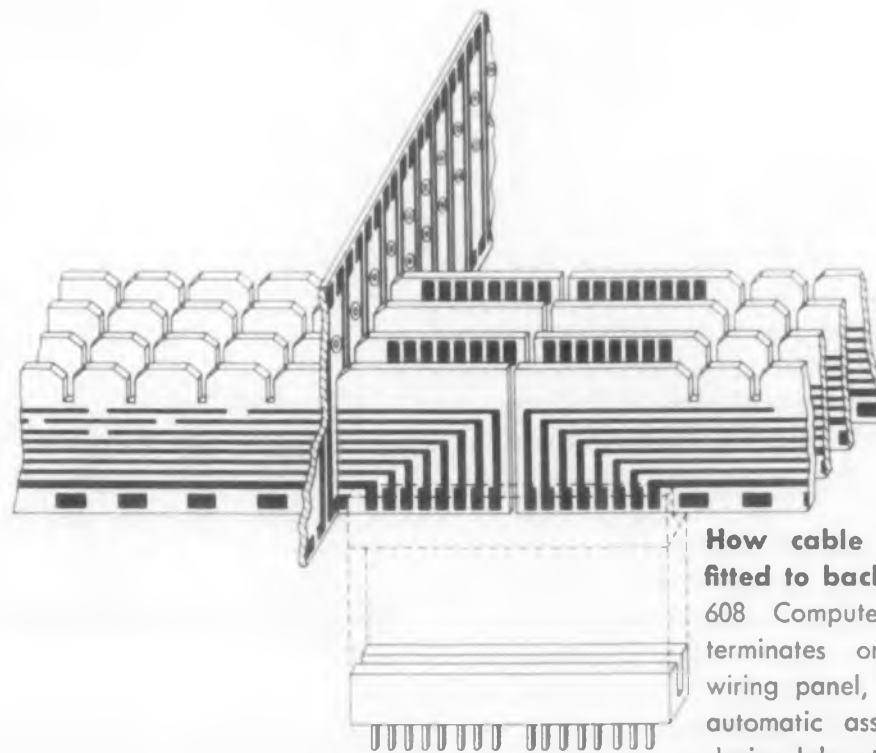
complished with commonly known techniques. Each layer can be wet laminated to the preceding laminate layer. This technique furnishes not only the high-density circuitry but its own supporting mounting board with a minimum of weight, designed strictly for structural reasons. Some techniques have been developed utilizing rolled sandwich structures. Flexible films such as Kel-F and copper foil have been laminated and then etched using the usual printed circuit techniques. This rolled printed circuit technique has made it possible to get a high circuit density in a relatively small volume of space but creates the problem of having a number of contact leads protruding from one end of the rolled package. Some people have even potted or encapsulated these rolled packages to assist in decreasing variables due to the effect of moisture and corrosion on circuit constants.

Reduces Cabling Costs

In the IBM 608 transistorized computer, three-dimensional printed circuitry not only in-



Printed Wiring storing register designed for IBM 608 transistorized computer. This arrangement makes most effective use of space and reduces need for cabling.



How cable receptacle is fitted to back panel of IBM 608 Computer. All cabling terminates on one printed wiring panel, thus facilitating automatic assembly and reducing labor time.

Increases the volumetric efficiency of the package as shown, but it reduces materially the amount of cabling required. All interconnections required are confined to one panel as indicated in the sketch. The conductors on the horizontal set of strips terminate as tabs along one edge of the strip. It is then possible to install a receptacle, as shown, on the two strip ends. If wires are attached to the terminals of the receptacles and correctly attached on their other ends to other terminals, automatic cabling is effected with the installation of the receptacle.

Cost-Saving Techniques

The following are some practices at companies interviewed, which for these companies have resulted in cost savings:

- Avoid odd shaped holes in the printed wiring board. Make all holes round, none rectangular.
- Use one-sided printed wiring with jumpers—no eyelets or plated-through holes.
- Keep the warpage in the short dimension, thereby utilizing cheapest base laminate.
- Spray XXXP laminate with protective coating after soldering to minimize moisture absorption, thus eliminating necessity for more expensive base laminate grades.
- Consider foaming (potting) of electronic circuitry to allow use of inexpensive laminate. Although a repair problem exists, it is usually possible to "dig" parts out of the foam without too much difficulty.
- Investigate new quick-print methods for printing a PW board.
- Use printed components as well as circuitry where appropriate—particularly applicable to microwave frequencies.
- Consider molding holes in the base laminate instead of punching.
- When component insertion is to be by hand assembly, avoid extreme accuracy in the PW art work.
- Don't design so close on tolerances that there is no leeway in manufacturing for hole locations, hole sizes, etc.
- Specify parts compatible with production technique to be used; for example, don't specify gold-plated contact pins where other printed wiring is solder tinned.
- Don't assume PW to be more economical than hand wired or cabled panels. Check into this.
- Don't be ashamed to ask manufacturing people for advice.
- Design sandwich-type printed circuitry where maximum circuit density is required.
- Consider two-sided printed circuitry for low volume production, particularly where space is a problem. Problems in registration, however, may require going to glass-fibre laminate for such two sided circuitry.

PYLE *star-line* CONNECTORS

Assure long-lasting protection of vital connections under a wide range of extreme environmental conditions

Currently establishing itself as a performance leader in the missile systems field, Pyle-Star-Line connectors offer engineers an entirely new line of electrical connectors for universal military and industrial use.

With characteristics of construction and performance never before combined in compact, rugged, lightweight standardized connectors, they exceed NEC requirements and classes A, B, C and E of military specifications MIL C-5015C.

FEATURES

Tough, lightweight shell: Strength comparable to mild steel, yet weighs only 1/3 as much.

Anodic coating: Gives shell toughness of case-hardened steel. Takes up to 1800 volts to penetrate coating.

"Sandwich" insulation: Silicone laminate floats between two rigid discs. Silicone disc absorbs shock, lets contacts align themselves freely; rigid discs impart just the right amount of restraint. Gives all advantages of both flexible and rigid mountings.

Chamber sealing: Silicone insulation disc positively and completely prevents water, gas, moisture or dust from passing into shell.

Wide range of pin and socket configurations: Configurations from 2 to 100 poles available. Within each form size all inserts are interchangeable and reversible.



Environmental Limits of Pyle-Star-Line connectors	
Temperature	-80 F. to 225 F.
Pressure	300 PSI External, 200 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015C
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015C
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015C
Air Leakage	Meet Class E Spec. of Mil C-5015C

Write today for complete specifications.

the PYLE-NATIONAL company



Where Quality is Traditional

1331 North Kostner Avenue, Chicago 51, Illinois

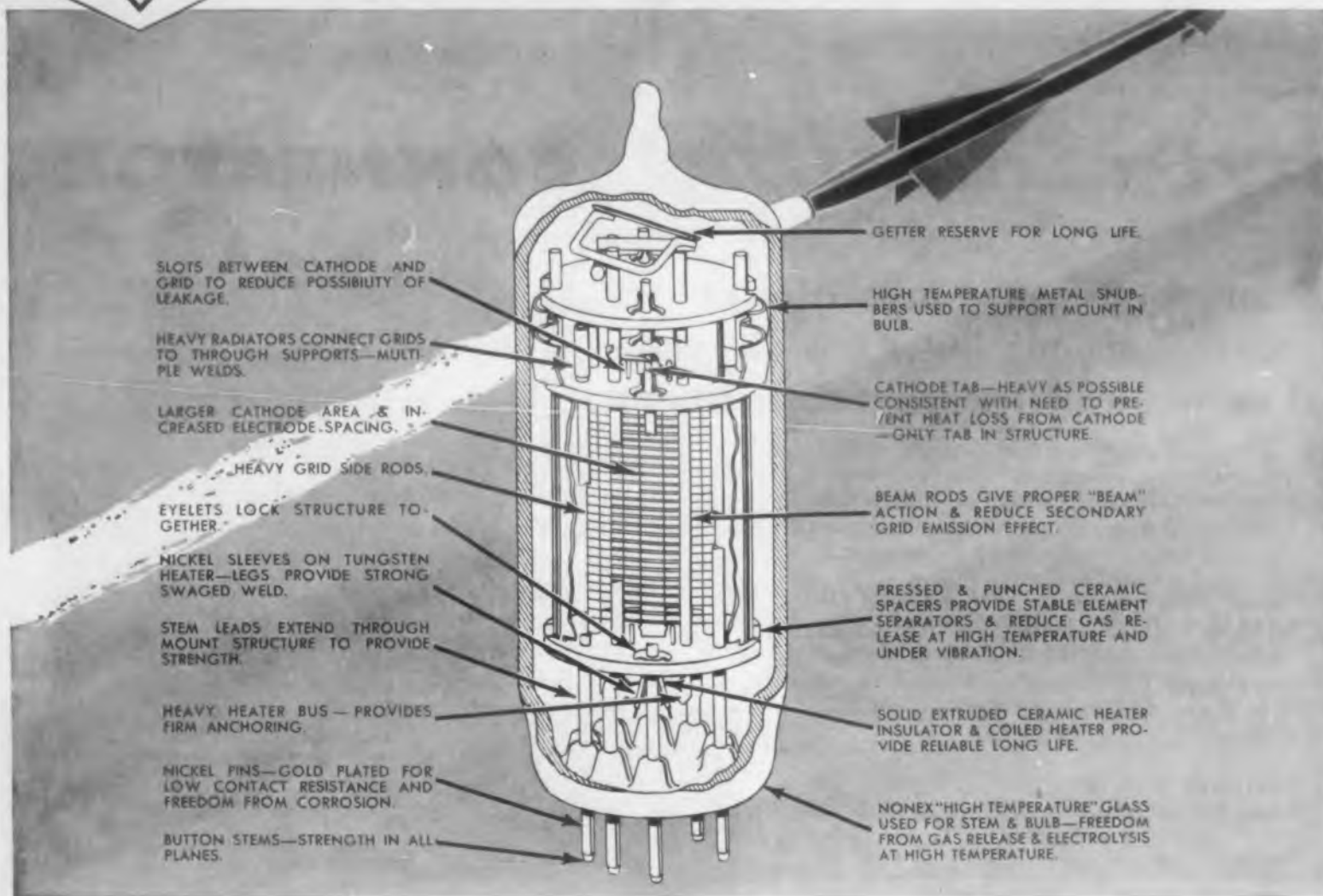
District Offices and Representatives in Principal Cities of the United States
CONDUIT FITTINGS • CIRCUIT CONTROLS • LIGHTING EQUIPMENT



CIRCLE 41 ON READER-SERVICE CARD

HY-G-300

ELECTRON TUBES FOR SURVIVAL



Design for
LOW-COST PRODUCTION

7 Sheet

DETAILED suggestions on sheet metal work are given in feature articles appearing elsewhere in this issue. Considerable savings can be obtained by proper sheet metal design. One of the greatest and most costly mistakes made by designers in specifying sheet metal fabrication is the insistence on tolerances which are unrealistic and in many cases difficult to obtain by simple sheet metal fabricating methods. Where tight tolerances are required these should be specified; otherwise, tolerances should be opened up as wide as possible. Also, drawings are often prepared showing design for one method of sheet metal fabrication when another method should have been considered based on the tolerances required. Any design which places tighter tolerance restrictions on a process than is generally obtainable by that process will be costly both in rejects, in maintenance of tooling, and in operating production facilities.

At IBM, standards have been established for tolerances in fabricated sheet metal as follows: linear sizes up to 6 in. $\pm 1/64$ in.; 6 to 24 in. $\pm 1/32$ in.; over 24 in. $\pm 1/16$ in. Spot weld locations should be specified no tighter than $\pm 1/4$ in. on centers. Corners of cabinets can be drawn, formed, welded or brazed, but in any event the outside corner radius must be from 1 to 2 times material thickness. When vendors are used, the designers should set quality (tolerances, etc.) limits on the specifications which go to vendors. Inside radii should be from 1-1/2 to 2 times material thickness for lowest cost; otherwise standard tooling cannot be used.

On shear, a tolerance of 1/16 in. in overall length for large items is necessary to avoid special handling. A formed edge must be straight within 1/2 of the total tolerance of its locating dimension. Flatness of surface must be within 1/64 in. in 12 inches. In welded construction, for lowest cost, don't specify removal of burrs and weld marks unless necessary. When neces-

WHY BENDIX* HY-G-300 ELECTRON TUBES ARE BEST FOR EXTREME SHOCK, VIBRATION AND TEMPERATURES!

From the standpoint of design features (see above), these reliable hard glass tubes offer the superior quality needed to survive today's severe environmental demands. Specifically, Bendix HY-G-300's are designed to withstand the following environmental conditions—bulb temperatures up to 300° C; vibration up to 20G's over the range of 5-2000 cycles; and shock of 200G's having 20-millisecond duration.

For full information about the HY-G-300 line . . . the surest answer to electron tube applications in jet aircraft, missiles and rockets . . . write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY. *TRADEMARK

West Coast Sales and Service: 117 E. Providencia, Burbank, Calif. • Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. • Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Que.

HY-G-300

TUBES ARE AVAILABLE FROM STOCK

Bulb Size	DbI. Triodes Volt Amp.	R. F. Pentodes	Gate Pentodes	Rectifiers FullWave	Beam Power	Power Triodes Passing
T-12	—	—	—	—	—	6080WB 6082A
T-11	—	—	—	—	6384 6889	—
T-9	—	—	—	6853	—	—
T-6½	6851 6854 6900	6582A	6486A	6754	6094	6877 6900

Retma Type No.	Retrofit For	Generic Type	E _f	I _f	Bulb	Bendix Type No.
6080WB	6080 6080WA	6080	6.3	2.5	T-12	TE-46
6094	—	6AQ5-6005	6.3	0.6	T-6½	TE-18
6853	6106 5Y3	5Y3	5.0	1.7	T-9	TE-45
6384	6AR6 6098	6AR6	6.3	1.2	T-11	TE-27
6854	6385	2C51 5670	6.3	0.5	T-6½	TE-47
6486A	6486	6AS6	6.3	0.25	T-6½	TE-43
6582A	6582	6AK5	6.3	0.25	T-6½	TE-44
6754	412A	—	6.3	1.0	T-6½	TE-36
6851	5751	—	6.3	0.5	T-6½	TE-42
6877	—	Half of 6080	6.3	0.8	T-6½	TE-48
6900	5687	5687	6.3	0.9	T-6½	TE-54
6889	—	—	6.3	1.2	T-11	TE-52
6082A	6082	6082	26.5	0.6	T-12	TE-55

Red Bank Division



CIRCLE 42 ON READER-SERVICE CARD

Metal Design

sary, removal of up to 10 per cent surface thickness is standard. All corner edges should be conditioned for safe handling in other manufacturing operations.

Defects in sheet metal can be corrected by use of soft-solder, putty etc. However, solder and putty for such purposes must stand environmental temperatures; and where high temperature will be experienced, special solders and puttys may be necessary.

Several design tips are:

- Watch loading of the metal and placement of parts with vibration in mind. If a chassis with its components withstands vibration, it will also normally stand shock test;
- Design equipment to be strong enough to withstand all vibration frequencies that will be expected. It should then generally operate satisfactorily without shock mounts;
- Use modular cabinets for short-runs, as these are available without tooling cost.

Joining and Sealing

Considerable material has been published in handbooks and technical journals on joint design using standard joining methods such as welding, soldering, riveting, etc. An excellent reference source on welding joint design is the fourth edition of the "Welding Handbook," published by the American Welding Society, 33 W. 39th Street, New York 18, N.Y. It stresses welding metallurgy, which is another way of saying that welding is becoming a science rather than a trade where welds must be tested in order to prove their strength. By controlling joint design, the materials to be welded, the welding rod material, temperature and pressure, the welding machinery and other environmental factors, it is now possible to predict with great certainty the quality of a weld, making it virtually unnecessary to 100 per cent test all welded joints as formerly.

no head bobbing—no board flopping



Translucent Formica[®] copper clad cuts assembly costs...

Assembly and inspection are easier, quicker and cheaper with translucent Formica copper clad boards. Hewlett-Packard Co., Palo Alto, California, reports substantial savings over opaque boards.

Translucency is an important property of many Formica copper clad laminates. Equally essential to top circuit performance are these other outstanding Formica properties: high in-

sulation resistance up to 1,000,000 megohms, cold punching to and including $\frac{1}{8}$ " 450°F solder temperature, 6 lbs. and higher bond strength. For complete information on how Formica can help you achieve better, low cost circuitry, write today for Copper Clad Technical Data bulletin 688. Formica Corporation, a subsidiary of American Cyanamid, 4512-7 Spring Grove Ave., Cincinnati 32, Ohio.

Save your engineers— use our engineering staff
... it's part of the complete laminated plastics service

FI-1425

subsidiary of

CYANAMID



- (1) Application Engineering
- (2) Research
- (3) Fabricating
- (4) Customer stock service

CIRCLE 43 ON READER-SERVICE CARD



8

Costs-Savings with Plastics

PLASTICS have not proven to be the cure-all in electronic design that engineers in recent years have been led to believe. In spite of advances in plastics technology and chemistry, more metals are being used in design today than ever before. But *so are plastics*. Plastics can do some jobs better than metals, can do some jobs no metals can do, and can save costs in production depending upon production quantities and complexity of designs.

One of the great difficulties with plastics is the problem in determining by sight the quality or durability of the plastic. Probably nowhere else in design is a knowledge of the vendor and his reputation more important. Yet, plastics have an advantage that almost any desired characteristics *can be* built in to the plastic molding compound. The old idea that plastics cannot be used for structural parts is definitely a fallacy. To illustrate, Raytheon's Plastics Group Research Division has developed a gear for a radar antenna mount molded in thermosetting epoxy resin. The result is a dimensionally stable mechanical assembly at 1/3 the cost of gray iron castings. The tooling (molds) are inexpensive. Standard tolerances achieved are ± 0.005 in., while 0.001 in. is possible. The plastic compound can be selected to match the metal ring expansion coefficient without difficulty.

Plastics are particularly useful where both insulation and structural rigidity are required. They also find wide application in cabinets and housings where special appearance can be obtained (color, shape, etc.) and where its lack of vulnerability to scratching during production line operations reduces rejects. For small quantity production, plastics are generally more expensive than metal parts. Yet, where the shape must be complex, the number of operations in metal that

might be required as compared with one molding operation in plastics might give plastics a considerable edge cost-wise. As a general rule, consider plastics when a problem develops using metal. For example: RF fields that cause trouble in metals may be minimized with plastics.

Plastics often create a problem in high temperature applications. However, use of thermosetting types allows for a maximum temperature operation of the material.

One increasing use for plastics is in the foam or potting category. Not only is foaming used to keep out moisture, and protect circuitry against other environmental effects, but some applications have been found where in high altitude aircraft applications it is desirable to keep heat out of the equipment. Here foaming helps.

The designer should recognize that realistic tolerances in plastic fabrication are different than with metal fabrications. In selecting a grade of plastic material the designer should recognize that impact resistance data is not an accurate indication of how the part will withstand impact. Cost savings will result from selecting the plastic material for the specific requirements needed *only*. Relying more upon placing the total problem before a molding house is a good procedure to follow. It is important that a prototype is designed in a manner that production tooling can produce the part.

Consult Vendors

Since the electronic designer cannot generally be a plastics expert, it is usually desirable to bring in vendors for consultation. It is first important to determine whether an application is practical for molded plastics before going further. Once so determined, the confusion that exists in determining the plastic material to spe-

city comes about from the fact that hundreds of different materials are available to choose from. The Society of the Plastics Industry Incorporated has outlined suggestions for designers in assuring that plastics are properly applied.

Information Needed

The first step is to supply the vendor with the following information:

- Physical requirements of the part; to ascertain if there is a plastics material for the purpose.
 - Design of the part and alterations which should be made. Can the part be molded?
 - Alternate requirements; to ascertain the economic feasibility of building a mold and amortizing it over the required number of parts.
- Assuming that it has been determined that the part can be most effectively made in plastics, further detailed information is required to determine the exact material and design:
- Function of the parts and the resultant chemical, mechanical, electrical, and thermal properties necessary.
 - Suggested compound and color desired.
 - Surface finish desired.
 - Must gate be ground flush?
 - Will tumbling or use of automatic mechanical devices suffice for flash removal?
 - Should flash line be filed and buffed?
 - Does the customer plan to do any finishing, such as painting, in his own plant?
 - Will ultimate consumer actually see part or portion of it?
 - How will the part be used in the next assembly?
 - Are inserts required and if so, how many and who is to supply them?
 - Should inserts be de-flashed?
 - Critical tolerances: Relax tolerances where-



This item shows what can be done with plastic to eliminate a great number of machining operations and final assembly. All components were positioned in a mold and the entire assembly cast in one unit. The only machined area will be exposed top surface of the casting. Application is the coil and gear assembly for a small boat radar tube-mount assembly. (Courtesy Plastics Research Div., Raytheon Mfg. Co.)

ever possible, but indicate clearly those which must be held.

- Permissible changes to improve molding.
- Location of the molder's monogram and cavity number.
- Bulk or individual packing? How many parts to a carton? Who supplies the cartons? Should the parts be wrapped? Nested? Packed in layers? How many to a carton? What type carton?
- Is there an existing mold or will you buy a new one? If there is an existing mold, furnish a sample part from the mold.
- Specifications of existing mold or suggestion for new one, such as type and number of cavities.
- Requirements per order, per year, per week, and ultimate. Quote in lots of _____.
- Samples required by _____ date.
- Description and explanation of the end use of the product.
- Production required by what date? Also, shipments required per day or week.
- Permissible location of knockouts.

The answer to each of the above questions has a direct effect on the cost of the molded part or the cost of producing the desired tooling. When the answers to these questions can be provided, the designer has accurately described to the vendor the services to be purchased. This assures that the item received will be in accordance with the design requirement, rather than in accordance with what a molder may interpret as the requirements of the designer.

The Vendor's Choice

There are various types of molding operations—compression, injection, extrusion, low-pressure, vacuum forming, etc. Some vendors are equipped to do certain types better than others. Specialists usually can hold closer tolerances than

those who provide a particular facility solely to round out their services to avoid losing a possible job. Geographical location may also be an important consideration, particularly because of liaison required and possibly because of delivery. The financial position of the vendor may also be important to assure satisfactory performance on the job. The Society of the Plastics Industry Incorporated has a list of qualified molders. Several should be asked to bid on a given job.

Where possible to furnish a sample for vendor's inspection, this is desirable, since it gives the supplier a better indication of surface finish and type of finishing required. Blueprints are satisfactory for tolerances and dimensions not readily obtainable from the sample. Where moldings are to be assembled with other items, samples of the mating parts should also be furnished if possible, particularly, if the mating could present a problem. It is also helpful to the molder to furnish information on your inspection procedure. Suggested design changes to facilitate moldings should be discussed in detail with vendor.

Check Methods of Billing

Unfortunately, there is no consistency in the manner in which charges are made for molding by different vendors. Some specify that they maintain molds and tools in their possession to furnish satisfactory parts subject to due allowance for ordinary wear and tear. Other molders specify that maintenance charges will be billed to the customer. This can mean as much as 10 per cent difference in prices submitted. Some molders carry fire insurance on the tools while they are in their plants; others do not. This again is a cost factor that should be considered. Be certain you understand what you are paying for in determining the lowest bidder on a molding job.

ELECTRO-MEC'S *New* DIGITOMETER™ (A Shaft Angle Digitalizer)

SHAFT POSITION TO NUMBERS
for record-indication or for computation.
NOW — A rugged shaft digitalizer
(non-ambiguous)
for AIRBORNE ENVIRONMENTS

NO BACKLASH • NO GEARS



TYPE 15

Diameter: 1.5"
Accuracy: 1 part in 256 parts for
360° of shaft rotation

TYPE 30

Diameter: 3.0"
Accuracy: 1 part in 1024 parts for
360° of shaft rotation

NO NON-AMBIGUITY NETWORKS

The system designer doing digital servo work recognizes the benefits of ELECTRO-MEC DIGITOMETERS because

1. Shaft position to electrical contact closures
2. No ambiguity (Gray Code)
3. Low shaft torque requirements
4. High slewing speed (650 rpm)
5. Small size
6. Lightweight
7. Designed to withstand the rigors of MIL (E) 5272 environmental test specification.

ELECTRO-MEC Laboratory, Inc.
47-51 33 Street, Long Island City 1, N. Y.

For data sheets or further information
write to our Engineering Dept.

CIRCLE 44 ON READER-SERVICE CARD



9

Packaging for Economy

THREE factors are important to consider in packaging electronic equipment—1. The function to be served by the package, 2. the appearance, 3. the cost. With military equipment, the packaging is generally dictated by contract specifications. But with commercial products, great leeway is allowed the designer in the design of his package.

The importance attached to various factors associated with packaging design varies greatly between companies. One company interviewed stated that they essentially throw cost to the wind on packaging, because they desire to achieve an

appearance which will sell their product to the public. Although reckless on packaging costs, they are downright "stingy" on other design costs. Some conservative companies spent considerable money on internal design and neglect packaging as somewhat unimportant. **ELECTRONIC DESIGN** editors tried to determine whether appearance could be obtained without excessive packaging expense incurring.

Here are some rules to follow that should help keep packaging costs down:

- Employ stock cans or modular cabinets, modifying them only enough to get distinctive ap-

pearance. This modification could consist simply of special hardware, special paint colors, name plate placement, dial design, etc. When buying stock cans or modular cabinets, tooling costs are avoided, and piece prices are a minimum.

- Reinforced plastic cases can be employed. This is done by Motorola, Inc. for some of their new portable phonographs. These fibre-glass cases have the color "built in," are rugged, and essentially damage-free. From a cost standpoint, not so much care must be given them on the production line to avoid scratches and nicks as often occurs with wood and fabric-coated cabinets.



Examples of getting appearance through custom enclosure design. This approach is not usually recommended if costs are important. In this case, designs were dictated by consumer demands and were considered worth the added costs involved. (Courtesy, Mark-Simpson Mfg. Co.)



Fibre-glass portable. Reinforced plastic cabinet is a feature of this new portable phonograph. Built-in color, ruggedness, scratch and stain resistance, and light weight all make it attractive. It is less costly to handle on the production line because of scratch resistance. (Courtesy, Motorola, Inc.)



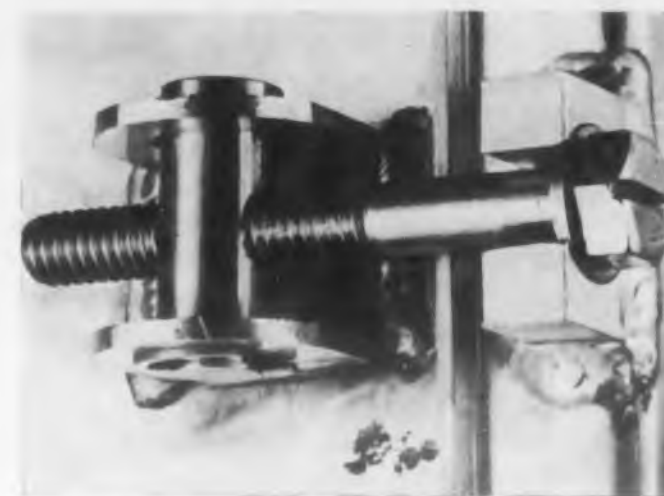
Leatherette Hi-Fi. "Standard" for portables for years has been the leatherette cabinet such as shown here on a new phonograph. Easily damaged during production, special care must be taken which costs money in labor, inspection rejects, and repair. (Courtesy, Motorola, Inc.)



Grained-Wood Ultra-Hi-Fi. Most costly and least serviceable is this deluxe hi-fi cabinet. The public attaches quality to fine grained-wood cabinetry. For the "exclusive" market, designing strictly for lowest cost based on function might put a company out of business! Good judgment is needed in analyzing all applicable factors in a "price." (Courtesy, Motorola, Inc.)



Type 561 Stromberg-Carlson Subscriber Carrier Equipment. Neatness and plug-in features not only make for functional design but reduce production and maintenance costs. The simple outer cabinet is designed to serve multiple purposes. The protective hood for servicing is actually part of the lid when cabinet is closed up. The table or working surface is also part of the lid when closed.



Cabinet latch used on all S-C Subscriber-Carrier units. Extremely functional, it is clever in its simplicity. Assembly is made with a minimum of labor cost. One snap ring holds the bearing laterally.

The main chassis for the S-C Subscriber Carrier. Packaging efficiency is obtained at low cost. The wrap-around enclosure is made of two identical sheet-metal fabrications fastened together by spot-welding. No high-priced tooling charges are entailed.

Motorola states that the fibre-glass cabinets are heat resistant, allow for molded-in colors, are extremely rugged, scratch and stain resistant as well as being light weight for portability. In spite of these advantages, the public seems to attach a degree of cheapness to plastic designs, and for the most expensive high-fidelity equipment, grained wood cabinets in mahogany, walnut, cherry, etc., are essential in order to sell. Here is a case where functional design cannot always determine the material to use, nor can the factor of function versus production cost always be applied. It is particularly important that designers check with Sales or the Consumer Products Department on such items where equipment is being designed for the general public.

- Break up large cabinet areas by trim or other means where possible. In this manner scratches won't show as much, and rejects can often be eliminated.
- Avoid specifying a smooth finish. It costs more than a grooved or wrinkled finish.
- Specify a medium sheen paint for economy. High-sheen paint shows flaws, while a matte finish shows finger marks.

- Grain masonite is less expensive than wood.
- Watch carefully the amount of material required in a cabinet, as well as the type of material employed and the number of production operations required to fabricate.

Commercial Packaging

In the commercial equipment line, Stromberg-Carlson has developed some cost-saving packaging concepts for their carrier telephone equipment. The equipment shown here is normally mounted on a telephone pole where it must withstand environmental conditions including rain and snow; at the same time, it must be readily accessible to a pole climber for easy maintenance. This equipment is also competitive so must be manufactured with costs in mind. Modular construction was employed to facilitate changing complete sub-chassis in the field. In construction of the case, simplicity of design is featured. It is necessary to have a chimney effect around the inner box to prevent the sun's rays from producing excessive internal temperature around the transistors employed. The internal case, however, is readily slipped in and out of

the outer case by removal of four bolts, two of which are shown on the left in the illustration. A handy working shelf is provided by a portion of the outer case which pulls down in opening for service, while the upper portion of the outer case serves as a hood to prevent the equipment from getting wet during service.

In design of the cabinetry, particular note was taken of tooling available to assure that the design was compatible with production facilities. Two pieces of sheet metal exactly alike form the complete enclosure around the carrier electronic units. No right and left hand cabinet sections are required. All material is aluminum, spot-welded in assembly.

The catches used for keeping the doors shut on the main box or cabinet were specially designed with two purposes in mind—ease of opening and closing by the maintenance man on the pole, even in bad weather, and cost reduction. The specially designed catch is shown in latched position. The exploded view of the movable components indicates the simplicity. Only one locking pin is required to prevent the bearing from lateral movement.



10

Process Evaluation and Value Analysis

FROM WHAT has been stated before it should be obvious that the design engineer cannot have too much knowledge of production methods and equipment. But how is he to get the necessary information and how about the time required to assimilate it? One answer comes from experience at the General Electric Company and Stromberg-Carlson Division of General Dynamics Corporation. These and other companies have so-called "Value Analysis" departments whose specific function is to examine a design to determine whether it facilitates lowest cost fabrication or whether changes can be made which will cut production costs without compromising the functional requirements of the part or equipment. At Stromberg-Carlson, for instance, this value analysis group serves as consultants to engineers and buyers. A big part of their job is to talk with vendors, peruse catalogs and process data, scout for low-cost items which could be modified readily to fit a new design, keep abreast of all new materials and processes, etc.

We interviewed Mr. L. D. Miles of Manufacturing Services Division, General Electric Company, on this whole subject of value analysis. Some of the questions we asked and the answers we received follow.

At what place in the design of new equipment should production costs be considered?

As soon as an engineer places a mark on paper he is specifying manufacturing techniques. Therefore, he cannot start too early to think about methods of production.

How much should the design engineer know about production methods?

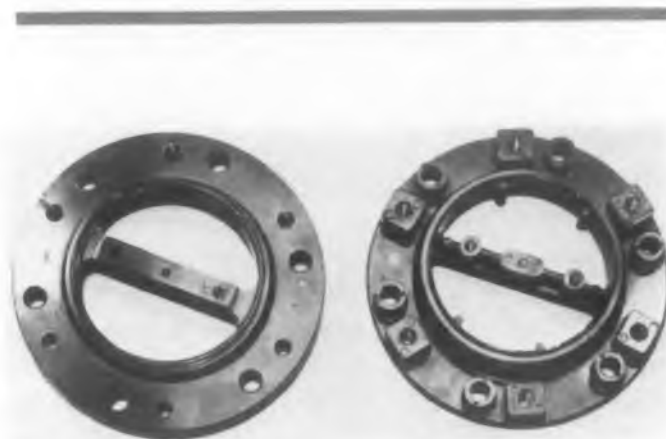
Every designer should know all about manufacturing methods but, no man can know all this and be an expert in his own engineering function, too. This is somewhat of a dilemma for which we hardly know the answer.

How much engineering time should go into evaluating processes of construction?

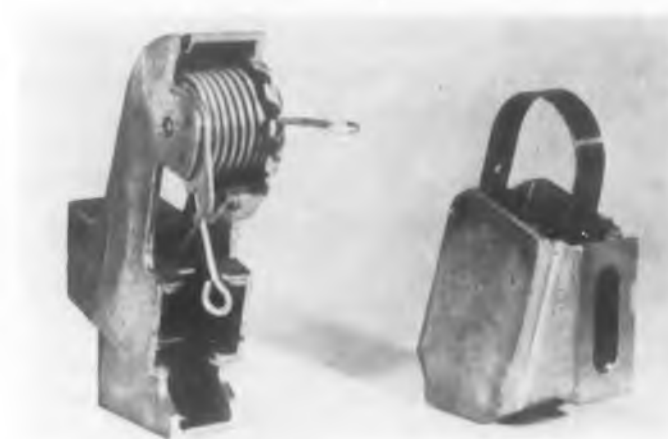
Possibly the engineer should quit at some given point and let someone else who is expert in manufacturing technique take over.

How can we keep from doing it wrong in the first place?

The designer can't always select the most manufactureable design because of time limits and other pressures brought upon him during design. Yet there are two ways he can avoid unnecessary mistakes.—1. Education and training, and, 2. Spot consultation when needed. For consultation, a professionally "value" trained man could be available to develop alternates. For training, he should teach draftsmen, designers, manufacturing, purchasing people in latest manufacturing methods, techniques, and ideas.



Pressure relief flange (left) for power transformer cost \$12.50 each when made from boiler plate. Redesigned as die casting (right) for \$1.82 each. Savings of **\$21,360 per year.** (G.E.)



Brush holder and spring assembly with wire spring and 11 parts (left) cost \$4.60 each; positive press spring, 2 parts, (right) cost \$2.00 each. Savings **\$78,000 a year.** (G.E.)



Binding post (left) was extruded brass shape costing 30 cents each; first approach (center) was sintered metal part-plating at 13 cents each; present (right) nickel-silver alloy plating cost 12 cents each. **Saving of \$18,744 a year.** (G.E.)



Terminal Clamp, a brass extrusion before (left) at cost of \$2.60C; after study, zinc die casting (right) at cost of \$1.02C. **Savings—\$1.58 per hundred.** (G.E.)

How large must a company be to warrant having a professional man trained in value analysis?

This is hard to say. Probably only experience can determine it. I would now say probably 1 to 2 million dollars annual sales.

Is there a particular thinking approach to design that will help assure producibility?

Yes, there is. The engineer should look at complete units by function rather than the individual components that make up the whole, such as resistors and capacitors. By considering complete units, components might be eliminated or changed in such a way as to reduce cost. A desire to seek out information from competent people in the production phases will pay dividends.

Why are opportunities missed by engineers who apparently have wide production experience?

This often occurs because of familiarity with certain processes rather than others. New processes are sometimes hard to evaluate because essential information is lacking. It often takes someone who spends full time developing alternatives to assure lowest cost design.

Examples of Cost-Savings in Re-Design

A few examples are shown where General Electric and Stromberg-Carlson have effected

CASTING PROCESS EVALUATION CHART

The values given in this table for tensile strength, yield strength and hardness are minimum and maximum values as determined from test bars. Where only a single value is given it is an average for the particular material. These values do not represent those secured in a formed part and can only be used for guidance, not for final design. The mechanical properties of shell mold castings are about the same as for sand castings. In some cases, shell mold castings may be slightly higher than for a comparable casting in a green sand mold.

The general characteristics are rated from 1 to 10 with the best properties, lowest costs, thinnest sections, etc. being rated as 1. For example, die castings have the highest tooling costs, the best finishability, the highest production time and the fastest production rate. Surface finish is about the best, porosity rather high and show the highest potential for machining savings.

The ratings of general characteristics are, of course, somewhat arbitrary, but represent the average opinions of several reliable sources. For the designer these ratings are of importance since the different processes can be compared on the basis of other factors than quoted costs.

This chart has been reproduced from the May, 1957, issue of Precision Metal Molding by kind permission of the Publishing Director.

	Ult. Tensile Strength-psi	Yield Strength psi	Hardness		Heat Treatability	Tooling Cost	Machinability	Finishability	Production Time			Labor	Surface (unfinished)	Porosity	Section Thickness	Possible Machining Saving
			Brinell						Tooling	Set-up	Rate					
DIE CASTING						10		1	10	10	1	2	1	5	1	1
Aluminum	30,000 45,000	16,000 27,000	50 80		5		5									
Magnesium	29,000 34,000	20,000 23,000	60 62		5		2									
Zinc	30,000 45,000		82 91				1									
INVESTMENT CASTING						8		4	5	2	6	6	3	3	2	2
Beryllium-Copper	55,000 170,000	20,000 150,000	107 372		1		1									
Bronze	Max 85,000		Max 185					3								
Aluminum	20,000 52,000		150		1		5									
Stainless Steel	61,000 200,000	34,500 184,000	132 375		8		7									
Tool Steel	88,000 187,000	63,000 181,000	88 550		1		4									
PERMANENT MOLD CASTING						7			3	2	3	3	3	2	2	2
Aluminum	261,000 48,000	6,000 40,000	45 140		2		5									
Magnesium	27,700 36,700	21,600 22,300			3		1									
PLASTER MOLD CASTING						1		6	1	1	10	5	1	2	10	3
Aluminum	19,000 40,000	7,000 32,000			2		5									
Brass								1								
POWDER METALLURGY						9		10	9	6	1	1	2	2 to 10	4	1
Brass	15,000 35,000						3									
Iron	12,000 200,000		115 650		5		3									
Nickel-Silver	14,000 42,000						2									
SHELL MOLD CASTING						2		8	2	5	4	4	5	6	6	5
Aluminum					3		5									
Magnesium					3		2									
Bronze							3									
Cast Iron							10									
High Strength Cast Iron					5		9									
Stainless Steel					8		7									



Brass screw machine control nut (left) cost 35 cents; was replaced by molded nylon nut (right) which cost 7 cents. **Savings \$24,000 a year.** (G.E.)



Forged insulator ball stud (left) cost 18 cents; was replaced by hot headed stud (right) which cost 12-1/2 cents. **Savings \$80,000 per year.** (G.E.)

considerable savings by redesigning equipment for new methods of production before and after designs are shown, and cost-savings are indicated in most cases. Some are quite outstanding.

Mr. Edward F. Miller at Stromberg-Carlson outlined some interesting ways in which savings were affected there:

- By using aluminum instead of brass they achieved three times the number of parts per pound for a resultant 35 to 40 per cent saving.
- By using commercial grade steel instead of quarter hard, a savings of nine dollars a ton has been obtained without sacrificing quality of finished part.
- By switching from machining to die casting of one small part, savings of thousands of dollars a year resulted.
- \$158,000 was saved by spending \$14,000 for special tooling in the redesign of certain parts in one year.

Some suggestions by Mr. Miller were:

- Don't be afraid to ask questions. You can't be sure you have the lowest cost design until you investigate fully.
- You may find that outside suppliers can cold punch material better and cheaper than can be done locally.
- Watch the process. Use of leaded steel increased tool life 40 per cent without any change in design.
- Finish on raw stock is important to consider. Don't specify a finish that isn't required.
- Cooperation between engineers and other de-



Original design employed a machined beryllium copper contact that was brazed to a flange and shell and subsequently heat treated. The new design uses a formed beryllium copper sheet contact which is heat treated prior to soft soldering to the mounting flange and shell. Another approach is to use an aluminum impact extrusion which combines the mounting flange and shell and a heat treated formed beryllium copper contact soft soldered in place to complete the assembly. The "new" design reduces the cost by 45 per cent over the original design. The proposed aluminum design would save an additional 15 per cent over the original design. The savings were made possible by design change and more economical materials and processes, than originally employed. [S-C]



MACHINED
BAR STOCK

OLD

partments is very important.

- Consider designs in powdered metal, particularly small parts.

Mr. Eades of Stromberg-Carlson suggests the following principles in approaching lowest cost production for a given equipment function:

1. **Simplicity of design.** Reduce the number of parts by combining parts, and eliminate non-functional parts.
2. **Realistic application of tolerances.** Tight tolerances increase costs exponentially.
3. **Substitution of materials.** Materials are selected on the basis of their initial cost and fabricating costs.
4. **Proper application of processes.** A review of 1, 2, and 3 above together with quantity and schedule information provides a basis for selecting the most economical process.
5. **Utilization of standard parts.** Yesterday's custom parts are today's standard parts.
6. **Utilization of specialty services and products.** Survival demands our keeping our fingers on the pulse of the time.

Navy Favors Value Engineering

The US Navy Bureau of Ships has recently issued military specification MIL-V-19858 (ships) on the subject: "Value Engineering." Some of the points made here are worthy of note:

- Avoid excess functions. Eliminate controls and circuits which duplicate functions available at other locations.
- Avoid excessive "safety" margins and any tolerances or technical requirements not specifically required or desired.

CIRCLE 45 ON READER-SERVICE CARD ►

THERE'S A GENERAL ELECTRIC IGNITRON FOR EVERY DESIGN NEED

Wide choice of Welding and Power Rectifier Tubes for the design engineer

STANDARD IGNITRONS

For Welding Service—KVA demand ratings from 300 through 2400 amps; or maximum average anode current from 22.4 through 355 amps.

For Power Rectifier Service—Continuous average amps 10 through 675; peak amps 30 through 3500; voltage ratings up to 20,000, inverse and forward.

CONVERTIBLE IGNITRONS

Available in same ratings as standard welding ignitrons (except GL-5550). Standard ignitrons have built-in thermal contact plate. Therefore, they can easily be converted to demountable-thermostat ignitrons.

Thermostat with flying leads—Thermostat gives over-temperature protection or water regulation.

Terminal-block thermostat—Thermostat gives over-temperature protection or water regulation.

TEMPERATURE-CONTROLLED IGNITRONS

Available in all welding and power rectifier ratings (except GL-5550). Over-temperature control and water regulation integral with tube.

PLASTIC-COATED IGNITRONS

Safety feature available on welding types. Red plastic shields workers from hazardous voltages. "DANGER ... VOLTAGE" stamped on plastic.

FACTORY-TESTED AT FULL RATINGS. Exclusive with General Electric is special factory test equipment that operates G-E ignitrons at full ratings under actual service conditions. You buy tubes proved-in-advance for service in your equipment. Every General Electric ignitron, moreover, is checked at the factory for the possibility of vacuum or water-jacket leakage.

HIGHEST-QUALITY IGNITORS. G-E ignitors will outlast others by as much as 2 to 1. Examples of 4-years-and-over G-E ignitor life are common; also cases in which G-E ignitors have outlived the tube. Reasons are: carefully controlled materials; holding the ignitor resistance to close limits; precision grinding.

CONTROLLED-GRAPHITE ANODES. By using a specially-developed electronic grade of graphite, with both density and size of particles controlled to tight limits,

General Electric is able to build ignitron anodes that stand up under extremely long and hard usage, give maximum life in heavy-duty service and under high-temperature conditions.

TRIPLE-DISTILLED-MERCURY POOLS. Mercury in G-E ignitron cathode pools is distilled to a point where impurity content is only 1 in 100,000 or less. Organic impurities, which can bring about gas formation, and inorganic materials, which can cause the ignitor to plate over, are held to a virtually irreducible minimum.

STABILIZED STAINLESS-STEEL JACKETS. General Electric uses stabilized stainless-steel for both inner and outer ignitron water-jackets. Characteristics of this material—its expansion and contraction, strength, chemical content—do not change with time or use. G-E ignitrons retain their full structural strength for life.

TURN THE PAGE FOR LIST OF G-E RECOMMENDED TYPES



CONSULT THIS LIST OF G-E RECOMMENDED TYPES FOR YOUR IGNITRON NEEDS

WELDING-CONTROL TUBES

TYPE NUMBER (All types available with plastic coating)	SIZE	SUPPLY VOLTS	MAXIMUM RATINGS**			
			KVA DEMAND	CORRESPONDING AVERAGE ANODE CURRENT, AMP	MAXIMUM AVERAGE ANODE CURRENT, AMP	CORRESPONDING KVA DEMAND
GL-5550	(A)	250-600 rms	300	12.1	22.4	100
GL-5551-A*	(B)	250-600 rms	600	30.2	56	200
GL-5552-A*	(C)	250-600 rms	1200	75.6	140	400
GL-5553-B*	(D)	250-600 rms	2400	192.0	355	800
GL-6346 ⊙	(B)	250-600 rms	600	30.2	56	200
GL-6347 ⊙	(C)	250-600 rms	1200	75.6	140	400
GL-6348 ⊙	(D)	250-600 rms	2400	192.0	355	800

*Can be converted to demountable-thermostat ignitrons using these kits: Water Control N-15272AA (flexible lead) Over-temperature Protection N-15273AA (flexible lead)
 N-15286AA (terminal block) N-15287AA (terminal block)

⊙ Built-in, temperature-controlled types. **Two tubes connected in inverse parallel.

FREQUENCY-CHANGER WELDING TUBES

TYPE NUMBER	MAXIMUM PEAK ANODE VOLTAGE		MAXIMUM ANODE CURRENT			
	INVERSE	FORWARD	PEAK	CORRESPONDING AVERAGE	AVERAGE	CORRESPONDING PEAK
GL-5551-A	1200	1200	600	5	22.5	135
	1500	1500	480	4	18	108
GL-5553-B	1200	1200	3000	40	140	840
	1500	1500	2400	32	112	672
GL-5822-A	1200	1200	1500	20	70	420
	1500	1500	1200	16	56	336
GL-6346 ⊙	1200	1200	600	5	22.5	135
	1500	1500	480	4	18	108
GL-6348 ⊙	1200	1200	3000	40	140	840
	1500	1500	2400	32	112	672
GL-6511 ⊙	1200	1200	1500	20	70	420
	1500	1500	1200	16	56	336

⊙ Built-in, temperature-controlled types.

POWER RECTIFIER TUBES

TYPE NUMBER	MAXIMUM ANODE RATINGS				
	PEAK VOLTS		PEAK AMP	CONTINUOUS AVERAGE AMP	AVERAGE AMP 1 MINUTE
	INVERSE	FORWARD			
GL-5779	350	350	30	10	
GL-5554	900	900	900	100	200
	2100	2100	600	75	150
GL-5555	900	900	1800	200	400
	2100	2100	1200	150	300
GL-5564	900	900	3600	400	800
	2100	2100	2400	300	600
GL-5788 ■	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6958	4000	4000	2000	300	600
GL-5630	20000	20000	200	50	50
GL-6228	20000	20000	900	150	300
GL-6512 ⊙	900	900	900	100	200
	2100	2100	600	75	150
GL-6513 ⊙	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6514 ⊙ ■	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6515 ⊙	900	900	3600	400	800
	2100	2100	2400	300	600

⊙ Built-in, temperature-controlled types.

■ Same ratings as GL-5555. These types will operate at higher water temperature and lower water pressure drop than type GL-5555.

POWER TUBE DEPARTMENT

GENERAL  ELECTRIC

9545 8481-5

SCHENECTADY, NEW YORK



MACHINED
DIE CASTING

NEW

Housing. A different process was considered in fabricating this housing. The cost of producing this item was reduced 33 per cent by replacing the machined bar stock housing with a machined die casting. The new housings are mechanically equivalent to the old machined part. (Stromberg-Carlson)

- Substitute parts or materials where possible to effect economies.
- Simplify circuitry where possible.
- Use standard hardware where possible to simplify fabrication of equipment.
- Investigate methods of assembly, processing and tooling, such as extrusion techniques, precision casting, plastic molding, printed wiring and circuits, and automation, which will reduce the contractor costs, and suggest methods for assembly which will not limit the supply sources for the equipment.
- Use patented circuits, parts, devices and processes if a saving in total cost (including royalty fees) will result.

Ask Yourself These Questions

In considering a design, a process, or a material, Mr. Miles of General Electric has suggested the following questions:

1. Does its use attribute value?
2. Is its cost proportionate to its usefulness?
3. Does it need all of its features?
4. Is there anything better for the intended use?
5. Can a usable part be made by a lower cost method?
6. Can a standard product be found which will be usable?
7. Is it made on proper tooling—considering quantities used?
8. Do material, reasonable labor, overhead, and profit total its cost?
9. Will another dependable supplier provide it for less?
10. Is any one buying it for less?

◀ CIRCLE 45 ON READER-SERVICE CARD



What every designer should know about . . .

High Temperature Electrical Insulation

**Mico Rigid Insulation,
Class H and C**
**Mico Flexible Insulation,
Class H**
**Mico Tubing,
Class H and C**
**Capacitor Grade Insulation
Fabrication**



MICA INSULATOR COMPANY
Schenectady 1, New York
A Subsidiary of Minnesota Mining & Manufacturing Co.

Now, for the first time, information on *all* Mico High Temperature Electrical Insulation for Class H and Class C applications has been gathered together in Mica's new **HIGH TEMPERATURE INSULATION HANDBOOK**. It is available on request. Here, for your ready reference, you'll find facts about molding plate, segment plate, heater plate, flexible plate, rigid laminates, flexible sheet laminates, laminated tapes, coated glass cloth and tapes, tubing, capacitor grade insulation and information on fabrication.

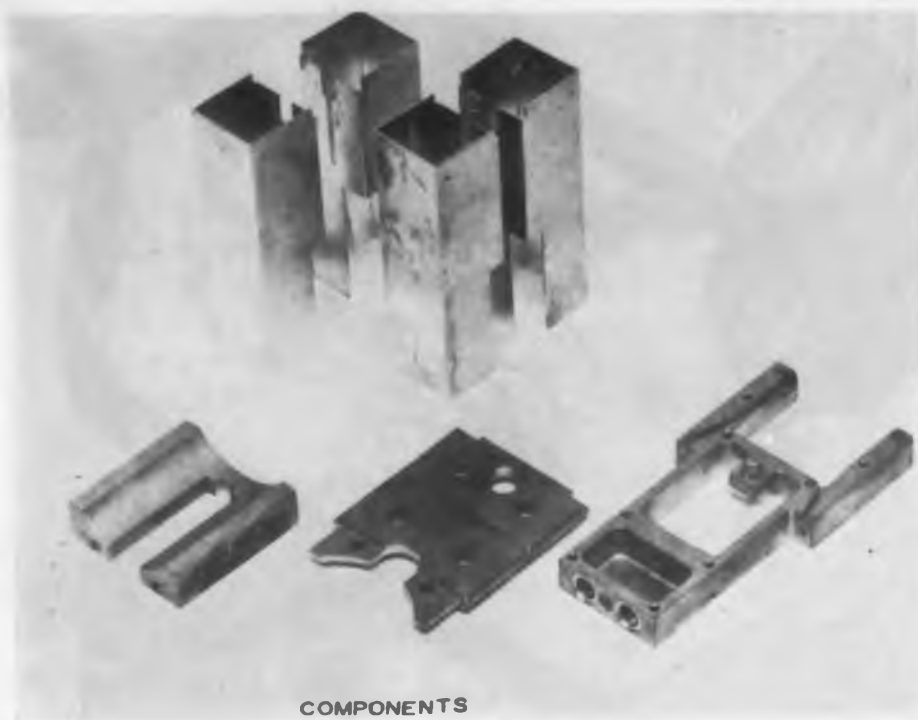
Insulation characteristics, performance data, application suggestions and complete tabulation of **ISOMICA®**, **MICANITE®**, **SAMICA®**, **LAMICOID®**, and **EMPIRE®** Products for high-temperature application are included to help you improve performance and reduce cost of your equipment.

JUST CLIP COUPON for your free copy of this new catalog . . .

Please send me a free copy of "MICO HIGH TEMPERATURE ELECTRICAL INSULATION."

NAME _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

◀ CIRCLE 46 ON READER-SERVICE CARD



COMPONENTS

Old



INVESTMENT CASTING

New

A single investment casting replaced the eleven parts previously brazed and soft soldered together. A 25 per cent reduction cost resulted. Assembly operations and a number of machining operations were eliminated. The new design gives comparable mechanical and electrical performance as well as greater uniformity in production. (Stromberg-Carlson)

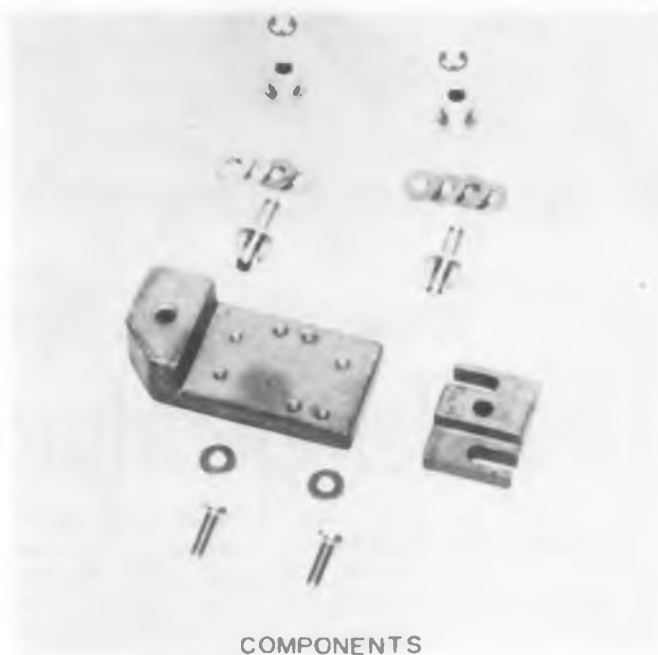


COMPONENTS



COMPLETED ASSEMBLY

Old



COMPONENTS



COMPLETED ASSEMBLY

New

The cost of this chain tightener has been reduced to 1/6 of its original cost. It was necessary to completely redesign the assembly using its function as the criteria. The new design employs different principles and bearing materials. The redesign permits the use

of a different process. The old investment castings have been replaced by die castings. Performance tests have proven the design to be mechanically acceptable. (Stromberg-Carlson)



STAINLESS STEEL

Old



BRASS

New

Threaded Sleeves. Price on these threaded sleeves was cut in half by changing the material from stainless steel with chrome flash, to plated-free machining brass. The brass provides satisfactory mechanical performance, and the protective plating gives sufficient corrosion resistance. (Stromberg-Carlson)

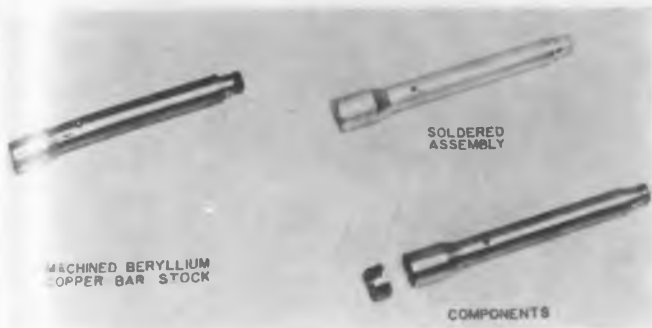


BRAZED & MACHINED ASSEMBLY

COMPONENTS

Old

Grid Line. Value Engineering has been able to reduce the cost of producing the parts shown in the accompanying photograph by 45 per cent. This was made possible by changing the process of manufacturing from



Old

New

Cathode Lines. The new assembly can be produced for 1/3 the cost of the old design. Originally a single piece of machined beryllium copper bar stock heat treated after machining, the new proposed design employs a body machined from free machining brass into which a heat treated formed sheet beryllium copper contact is soft soldered. Savings are from the use of the lower cost material for the largest portion of the line. The heat treating of the completely machined part has been eliminated and replaced by the relatively inexpensive heat treating of the formed beryllium copper.



MACHINED EXTRUSION



ALUMINUM IMPACT EXTRUSION

New

an assembly of three brass parts, two screw machine parts, and one piece of brass tubing, brazed together and finish machined to a single part machined from an aluminum impact extruded blank. (Stromberg-Carlson)

NOW...

Ruggedized

PANEL METERS

with

LONG

250°

SCALES

First with a comprehensive line of ruggedized d-c and a-c panel meters, Weston now provides these instruments in the popular 3 1/2" size with *long readable scales, higher accuracy, improved sensitivities and superior ballistic characteristics.* Designed to meet, and surpass in scale length and accuracy, all requirements of MIL-M-10304A. They incorporate all Weston ruggedized design features including integrally molded and bonded shock mounting plates; shock-absorbing spring-backed jewels; screw driver type zero correctors, front sealed; anti-static treated plastic sealed windows; self shielding etc. For all the facts, consult your nearest Weston representative, or write—Weston Electrical Instrument Corporation, Newark 12, New Jersey.

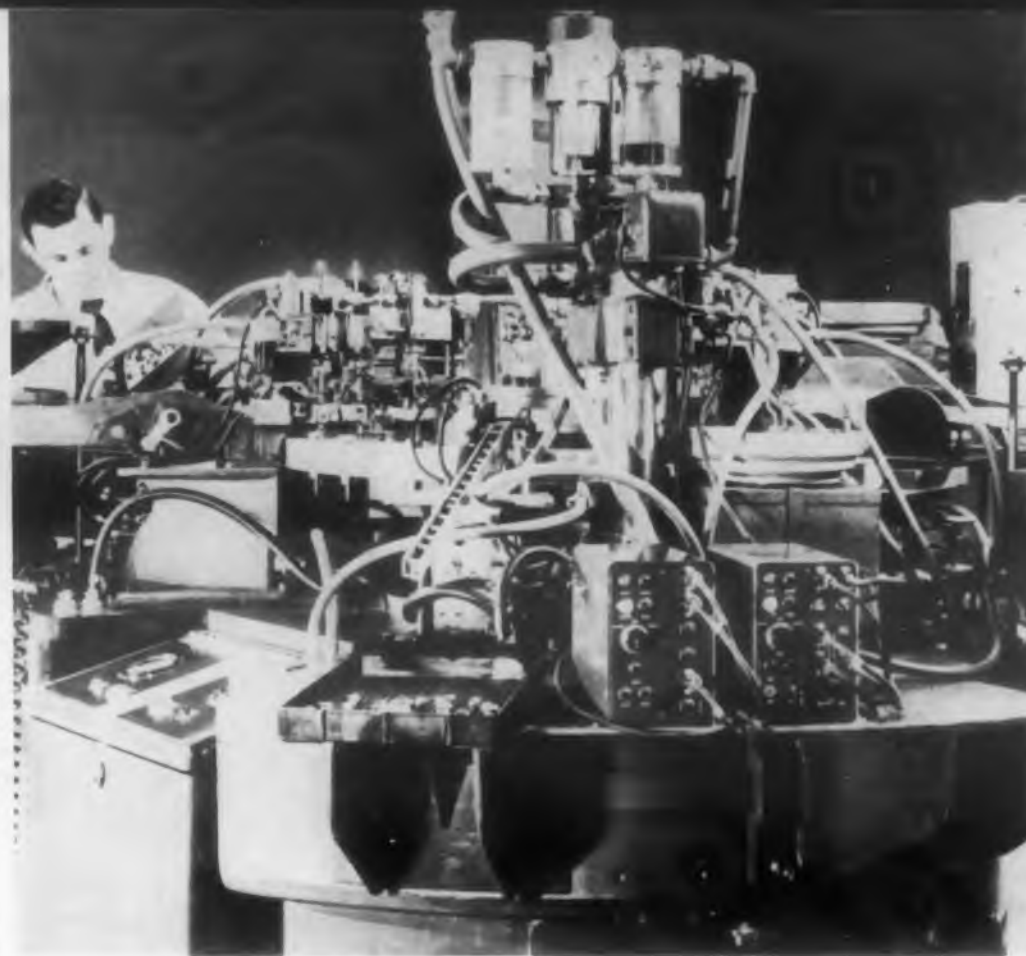


WESTON

Instruments



CIRCLE 47 ON READER-SERVICE CARD



11 Hand Assembly vs Automatic Production

BOTH THE technical and popular press have made so much bally-hoo about "automation" over the past few years that the Russians, according to a reliable report, spent thousands of dollars automating an assembly line on the assumption that it was unquestionably automated in the United States. In the course of this they sent representatives here to see how we did it, only to learn that we were still inserting components on this particular line by hand! The moral here is that one should not go blindly into setting up automatic processing lines until a careful determination of the economies of the situation has been made. It is now quite evident that companies who invested a hundred thousand dollars or more in mechanized equipment for automatic production have white elephants on their hands and are unable to amortize the expensive equipment over the number of production units involved. Yet, there are all types of automatic-assembly lines that are producing economies—ranging all the way from a few semi-automatic stations on the line, to completely automatic assembly with feed-back information which eliminates the need for production workers.

When one thinks of automation in the electronics industry, he automatically thinks of printed wiring. Printed wiring has made automatic assembly practical in our industry. The extent to which this is so was made crystal clear at the first national symposium on production tech-

niques in Washington on June seventh. All discussion centered around printed wiring techniques. Some of the points made are listed below in the hope that they may help in the design concept to facilitate lower-cost production.

The following remarks were made by George Harrigan of Admiral Corporation, where production is in large volume of highly competitive equipment:

- Most all printed wiring boards (at Admiral) have multiple applications. The punching die contains all the punches to supply the holes required for several circuits. Therefore, all the holes are punched on each board, whether they are needed or not. This saves in cost, changeover time, and inventory control.
- Selective soldering of printed circuit boards is now employed primarily because it is much easier to scan a board for quality control when broken up into alternate copper and solder areas; also, the probability of bridging is reduced with resultant need for very little touch up.
- Screening is employed in preference to photo deposited resist since no great delicacy of pattern is required. This results in considerable economy.
- Mylar capacitors are used in place of conventional waxed-paper capacitors because they conserve printed board space and withstand higher temperatures.
- By inserting all terminal pins in one automatic insertion operation on a given printed wiring

board, 20 per cent labor saving per chassis was obtained.

Careful liaison between engineering and production foremen effects maximum economies.

Standardization Important

In speaking before the same symposium on the subject "Automating Small Lot Electronic Production," William A. Schneider, Vice-President of Stavid Engineering, Inc., stated "The designer may be faced with the requirement of choosing and evaluating non-JAN components. He must use unusual discretion in the choice of these components; for any change in the mid-stream of production due to failure of the component or the lack of sufficient quantities of the component may be prohibitively expensive." Schneider also points out the serious problem of lack of standardization in components—particularly mechanical features such as form factor, size, and termination method for resistors, capacitors, diodes, vacuum tubes, transformers, etc. Fortunately, great strides have been made recently in this area and much effort is going into further standardization.

Another problem raised by Schneider is a lack of adequate hardware for electronic circuits, including eyelets, inter-facial connectors, and vacuum tube sockets. Any new parts developed should satisfy the following requirements:

1. They should be designed for mechanized insertion of components.

2. They should include repairable and non-repairable items.
3. The hardware itself should be mechanizable.

Some problems highlighted by Schneider that have held up many otherwise "naturals" for automation have been the following:

1. Lack of standardization in the use of a grid system. (This has now been essentially resolved by announcement of "grid" standards by RETMA.)
2. Lack of reliable information on plating processes, such as gold, silver, nickel, and rhodium.
3. The approaching era of ultra-high temperatures and the inadequacies of present techniques in this area.
4. Reluctance of military-system manufacturers to consider mechanization because of insufficient information on techniques available or insufficient quantities to justify mechanized production. (Answer to this seems to lie in the development of semi-mechanized techniques and inexpensive mechanized equipment.)

The Signal Corps Position

A. W. Rogers of The Signal Corps expressed the opinion that lack of standards is the number-one problem in getting automation on its feet and as a result has set down a number of rules for design for Signal Corps equipment, hoping that some of these rules will be adopted across the board for all electronic equipment. Some of the points Mr. Rogers makes are:

- Circuitry shall be divided into modular units on a functional basis.
- Design of modular units and associated integrating circuitry shall be based on the use of printed wiring assemblies.
- Designs shall be on the basis of sub-assemblies which are readily fabricated by automation and readily replaceable in the field.
- Printed wiring shall be on one side of the board only to facilitate automatic assembly.
- Etching of foil-plastic laminates is preferred for fabricating printed wiring boards.
- Conductor size must be adequate to keep within temperature limitations of the base material. Minimum line width 0.030 in. for general applications with 0.020 in. allowed where extreme miniaturization is essential.

- Epoxy-type conformal coating shall be used on the pattern side to protect printed wiring against moisture and contamination.

- Minimum spacing of coated printed wiring for circuitry involving less than 50 w of power shall be: 50 v—0.060 in.; 300 v—0.030 in.; 100 v—0.020 in. For 50 to 2000 w applications, minimum spacings are doubled. No spacings have been established for high altitudes. Where printed wiring is uncoated, minimum spacings shall be four to five times those for coated circuitry.

- Parts shall be seated firmly against the printed wiring board or other support.

- Leads shall be soldered to printed wiring on the opposite side of the printed-wiring board.

- Diameters of mounting holes for leads shall not exceed by more than 0.015 in. the corresponding cross-sectional dimensions of the lead.

- Leads shall be clinched or flared slightly after insertion through the printed wiring board where feasible.

- No mechanical eyelets or stand-off terminals for electrical connections shall be used except where unavoidable.

- Plated-through holes shall not be used alone to effect interface connections.

- Moisture traps shall be avoided in the design and mounting of all parts.

- Where practical, conformal coating shall be applied to the electronic parts side of the assembly, as well as the printed wiring side to immobilize the parts.

Rogers points up a particularly important factor in good design for automation—*volumetric efficiency*. Realizing that more equipment must be gotten into smaller and smaller space, it may be surprising to find that with machine-made modules, "an actual usage of 30 per cent of the total volume is considered an exceptionally good design. When these modules are integrated into complete equipment, a 50 per cent loss in space results giving an over-all equipment volume efficiency no greater than 15 per cent." Rogers suggests that designers work toward packaging efficiency of the module of 80 per cent through better packaging techniques, which might conceivably give an over-all equipment volumetric efficiency of 40 to 50 per cent.

THERMAL DESIGN PROBLEMS?

(Here's big news about thermally stable Hymu "80" laminations)

EUREKA! THIS IS IT!.. WE WILL CALL THEM THERMALLY STABLE LAMINATIONS!

FROM -55°C TO +85°C THEY REMAIN STABLE AND NO OTHER LAMINATION CAN MAKE THAT STATEMENT!

ORDINARY LAMS → **THAT'S US!**

YES! USE THERMALLY STABLE LAMINATIONS WHERE HIGH PERMEABILITY MUST REMAIN CONSTANT OVER A WIDE TEMPERATURE RANGE

WE ASKED 4,852 TOP ENGINEERS AND GUESS WHAT WAS MOSTLY ON THEIR MINDS?...

WE HAVE MORE INFORMATION FOR YOU!.. JUST ASK US!

CURVES SHOW 1/3 OF THE VARIATION IN THIS MATERIAL COMPARED WITH REGULAR HYMU "80"

USE 'EM FOR ROCKETS OR ANY OLD THING!

THERMALLY ACTIVE COMPONENTS

OUR HAPPY HOME

ADVERTISING

Magnetic Metals Company is processing Hymu "80" transformer laminations which will remain stable at temperatures from -55°C to +85°C. Core designers will find of great value the combination of thermal stability and reliable high permeability at low density. Laminations for a variety of applications are available in this material.

MAGNETIC METALS COMPANY



ELECTROMAGNETIC CORES and SHIELDS

HAYES AVENUE AT 21st STREET • CAMDEN 1, N. J.

CIRCLE 48 ON READER-SERVICE CARD



Designs for Low-Cost Production

12

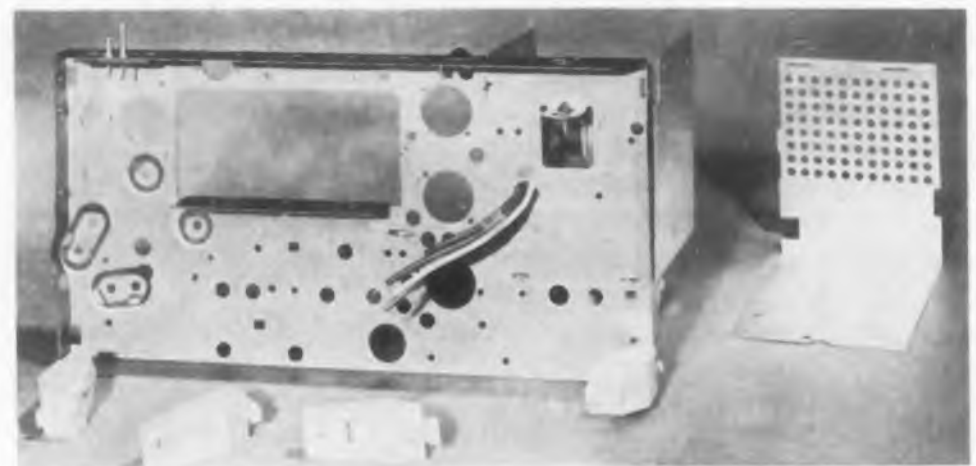
The designs illustrated here have been selected because of interesting features which particularly lend themselves to low-cost production. In many cases the design evolved around a low-cost production method. In other cases existing high cost designs were re-evaluated to see how costs could be squeezed out of the design. In all cases considerable savings resulted.



Sylvania Portable Chassis with 110 deg cathode ray tube. Note the simplicity of design and lack of cabling leads. Components, including controls, have been placed physically where they serve functionally to eliminate long leads and cabling problems. Sheet metal is reduced to a minimum, and what sheet metal there is is designed for low-cost tooling. Turnplate is used for the chassis because it is cheaper than cadmium-plated steel and easy to solder. Holes in frame members are extruded to allow sufficient material for self tapping screws.



Banding stock is employed to hold the TV picture-tube in place. Sleeving over the banding stock as shown prevents injury to the glass envelope. This is a very inexpensive but effective arrangement.

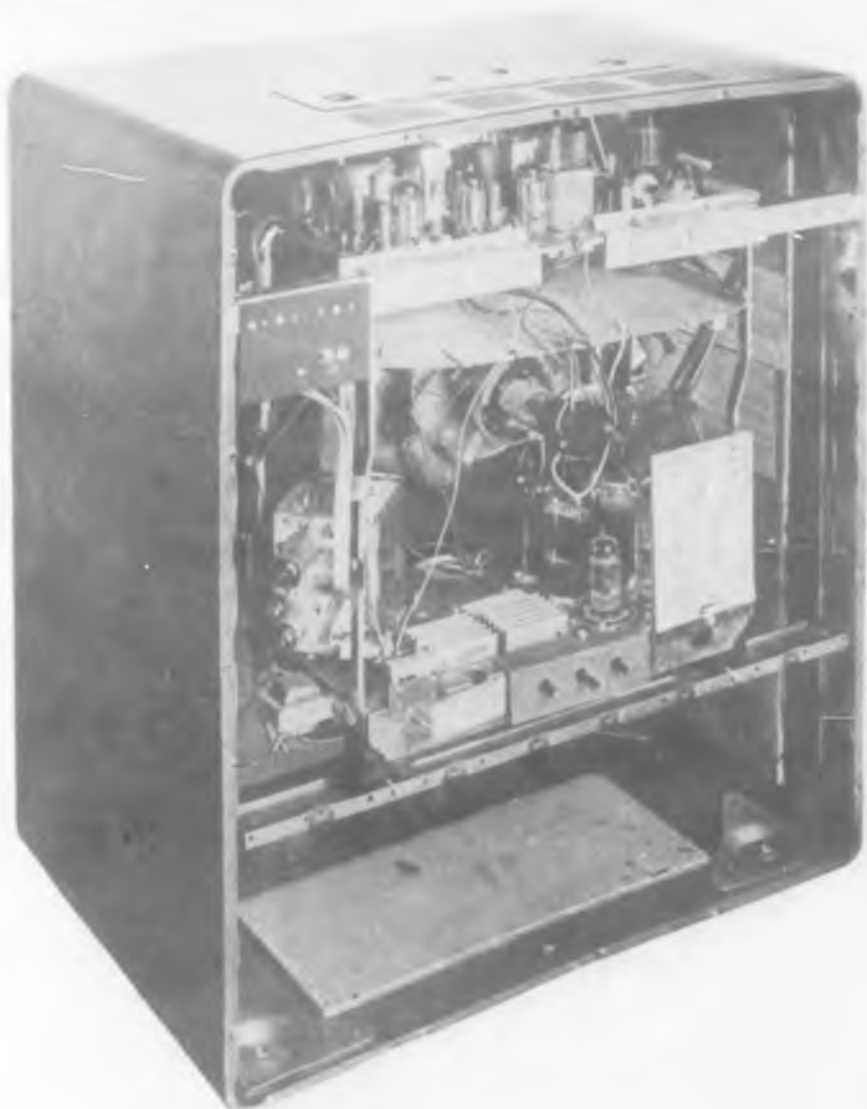


All sheet metal work involved is shown here. Note simplicity of design. The mounting feet shown are molded plastic. The design allows the feet to slip into slots in the bottom of the cabinet, holding the chassis firmly in position without bottom mounting screws. The high-voltage dust cover is held in place by twist tabs which are readily fastened on the production line by use of long-nose pliers.



Universal printed wiring boards are used for all models in production. Where control shafts come out the top of the cabinet, the controls are mounted as shown at right; when control shafts protrude at rear, controls are mounted as shown at left. The holes in the boards provide for either method of mounting, thus saving costs.

Photos courtesy Sylvania Electric



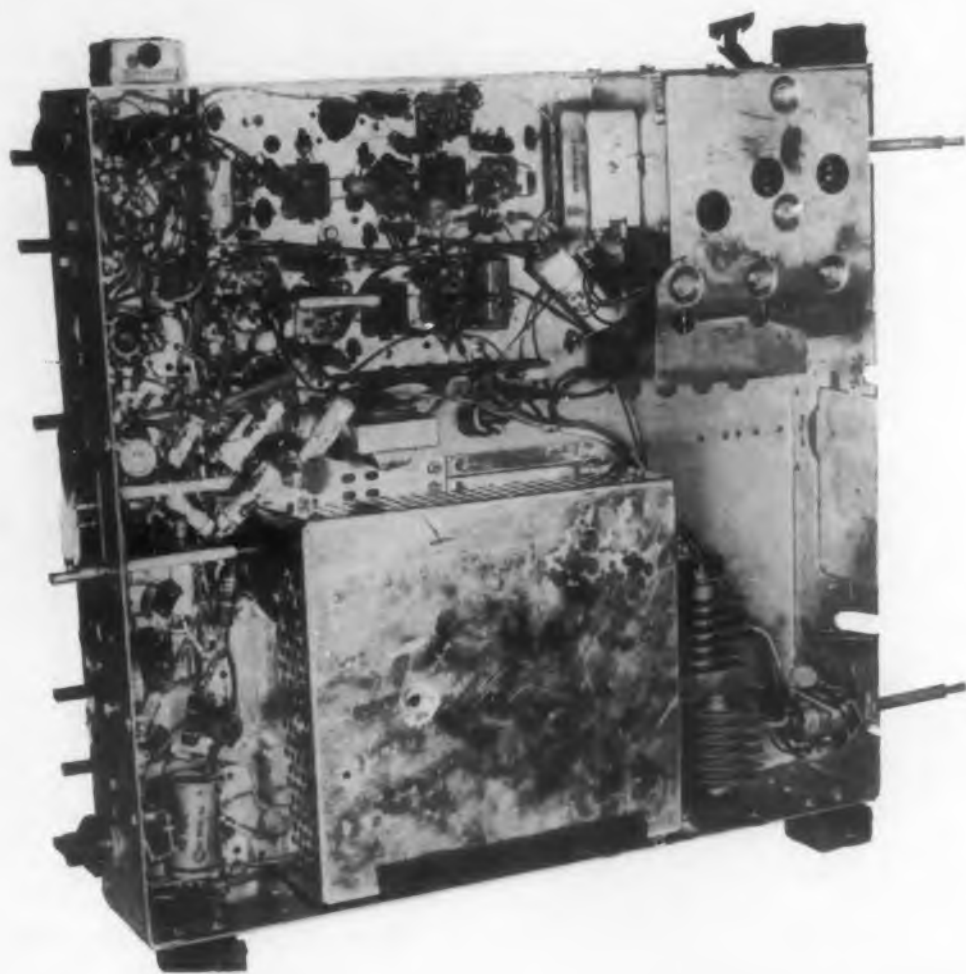
110 deg chassis inserted in table console. Note simplicity of cabinet design. No supporting shelf is provided for the chassis; rather, a lower cross-brace supports the lower rear portion of the power supply chassis while two partial brackets support the top rear of the printed wiring chassis. The same self-tapping screws are used not only in all metal applications but also to attach components to wood cabinets. This results in the stocking of only a few sizes of sheet-metal screws and no wood screws.



Construction is unsupported (top) until a p-w board is inserted in place (below). Rolled channel, which comes in stripped form, is inexpensive but does an adequate job of supporting components as seen at bottom when printed wiring board is fastened in place. Self-tapping screws are used throughout with hex heads to facilitate use of automatic screw drivers.



12



Contrasting TV chassis—the old design above and new design right—showing where 90 per cent of traditional wiring has been eliminated by a combination of printed circuit boards and packaged electronic circuits. Production line costs as well as material costs were greatly reduced, and servicing was greatly simplified. Photos courtesy Motorola, Inc.

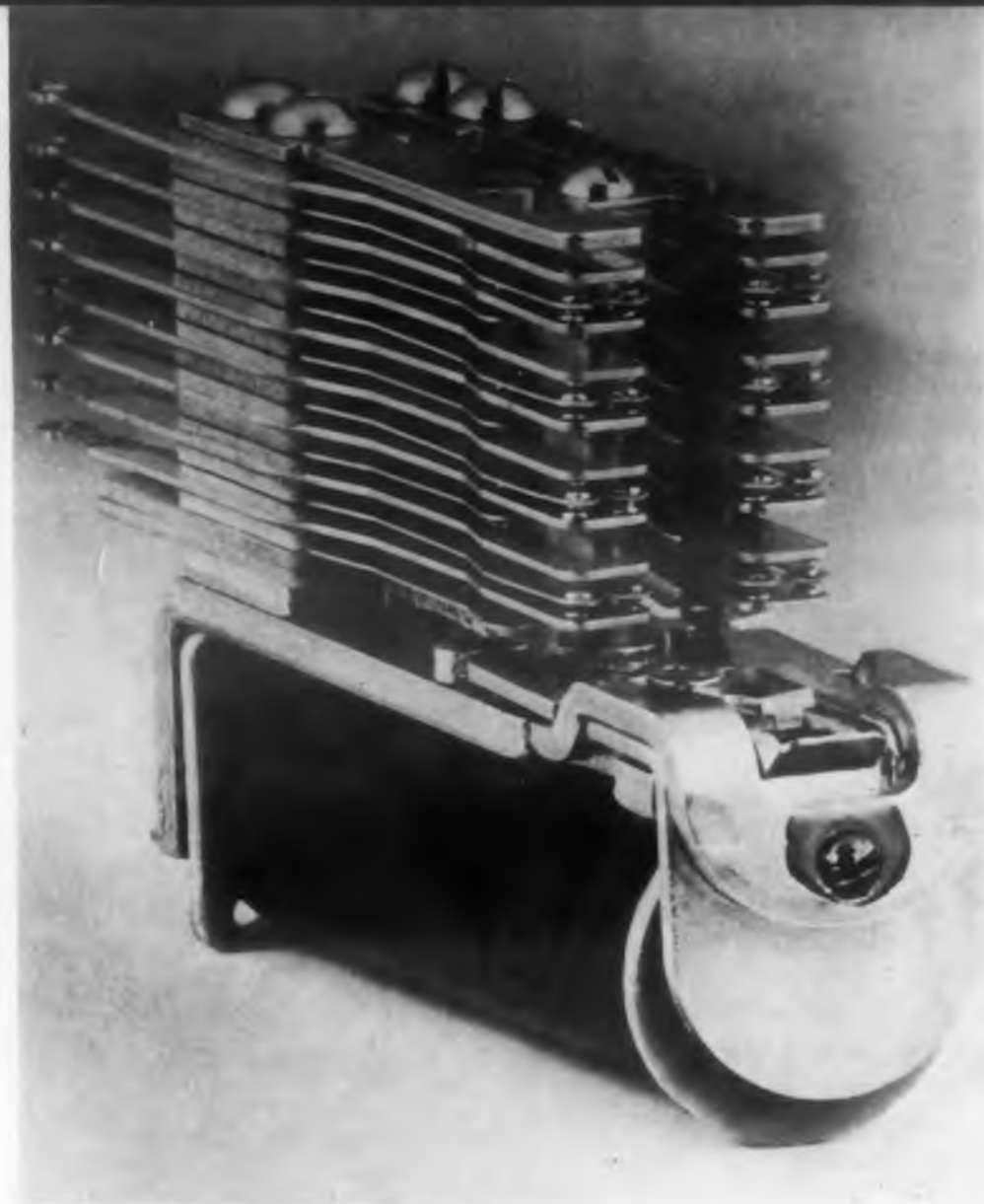
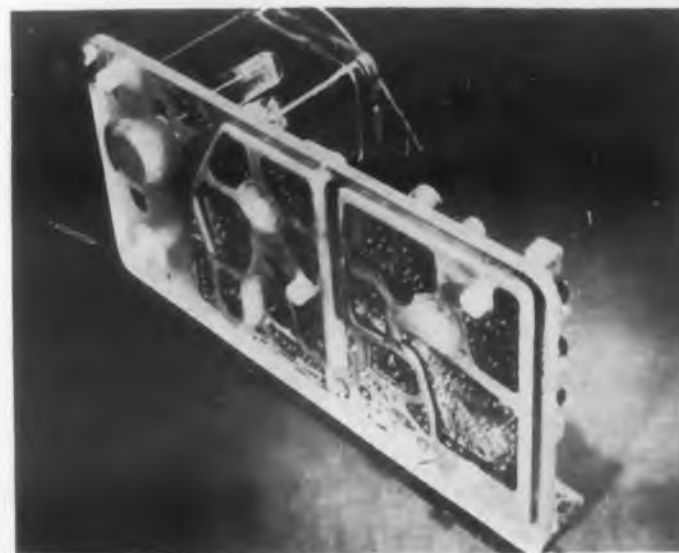


Photo courtesy Stromberg-Carlson

Telephone type relay. A simple redesign on this relay saved \$22,800 a year. This is a so-called double stacked relay with contacts built up in two piles as shown. Originally, individual spacers were inserted between the contact leaves of each stack separately. By redesigning the spacers to use a single spacer for the two stacks, the number of spacers to be stacked was reduced to half; yet, the material cost was only 15 per cent greater than for a single stack and cost of the assembly operation was reduced materially.





Weston model 980 multi-range tester. Here is an excellent example of achieving high quality at considerable savings. The instrument features manufacturing simplicity and ease of maintenance. In assembly into the case, only 2 studs, 6 screws, and 3 press-type nuts are used.

Photos courtesy Weston Electrical Instrument Corp.



Meter movement, showing unit base and lucite case. A total of eight screw fastenings assemble the unit. The meter mechanism is of core magnet design, eliminating need for magnetic shielding. An alkyd resin base plate is used for the scale instead of the expensive blank metal plate formerly used. A white background is spray-painted on this base plate, after which the scale is printed by off-set printing method.



Electronic Designers:

OVER 250 MODELS OF JOY FANS ...

... Designed especially for
your applications

LIGHTWEIGHT because they are made of aluminum or magnesium castings produced in Joy's own foundries.

COMPACT design—with motor mounted inside the fan—permits installation anywhere . . . even inside a duct.

EFFICIENT vaneaxial design provides more air per given size than any other type fan.

AVAILABLE on a production line basis . . . Joy has over 250 standard models with 1300 designs available to your specs . . . from 1/500th horsepower up.

RUGGED because of simple design . . . the outer casing, the vanes and motor mounts are cast in one piece . . . vibration free.

Get more information from the world's largest manufacturer and supplier of vaneaxial fans to companies like G.E., Hallicrafters, Lear, R.C.A., Motorola, Raytheon, Sylvania.

Write to **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: **Joy Manufacturing Company (Canada) Limited, Galt, Ontario.**



Write for **FREE**
Bulletin 135-57

WSW 16348-135

CIRCLE 49 ON READER-SERVICE CARD

JOY

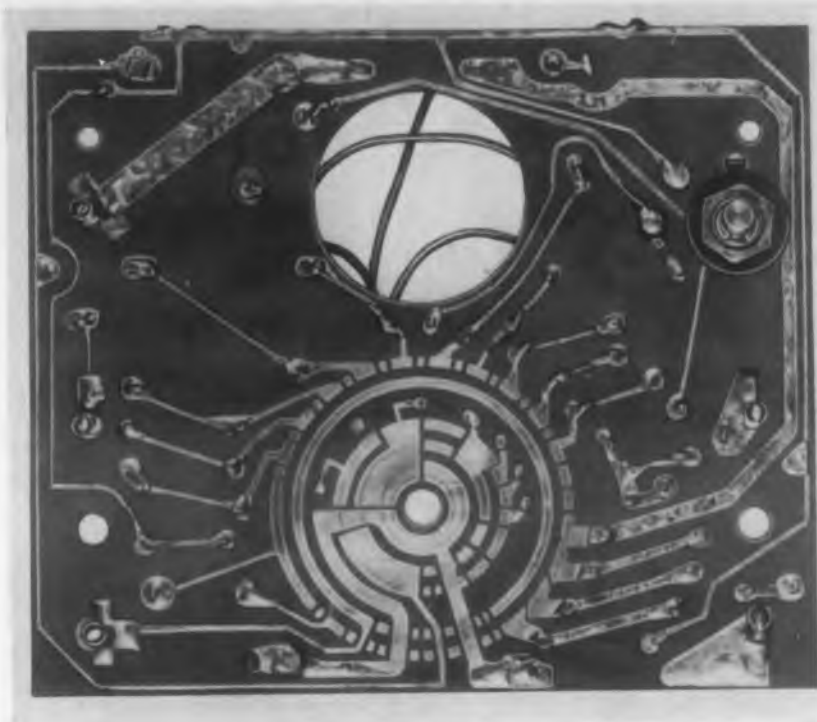
**WORLD'S LARGEST MANUFACTURER
OF VANEAXIAL-TYPE FANS**



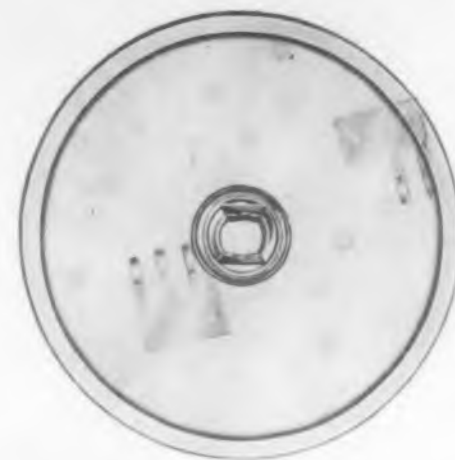
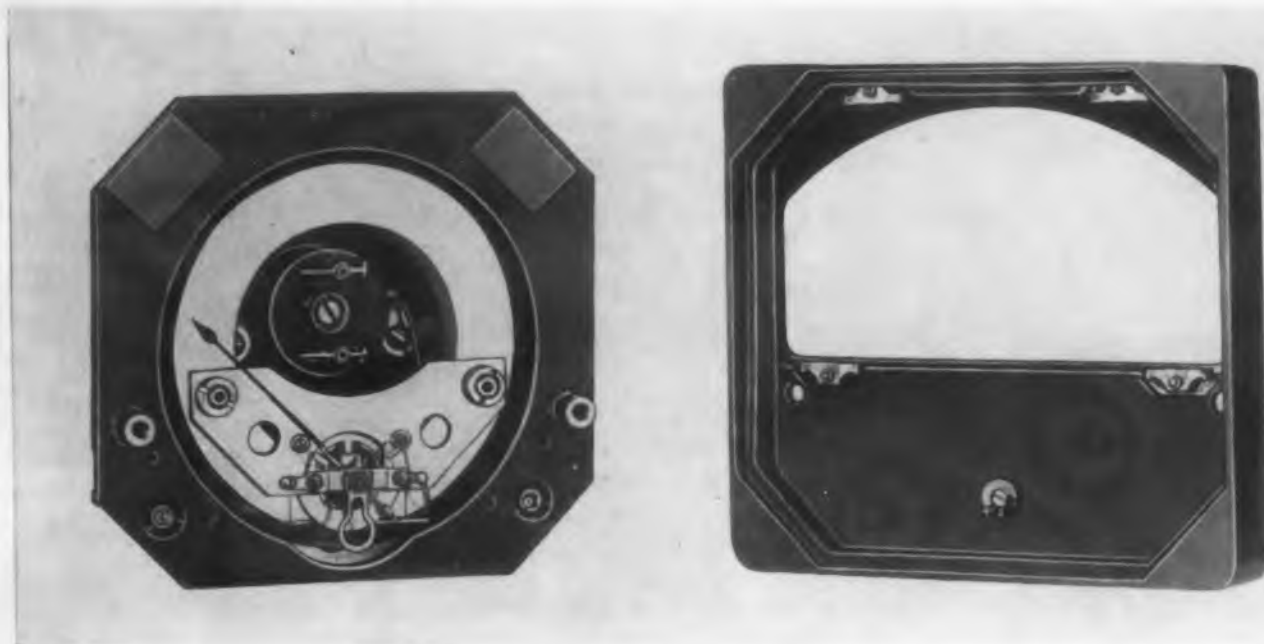


Design for LOW-COST PRODUCTION

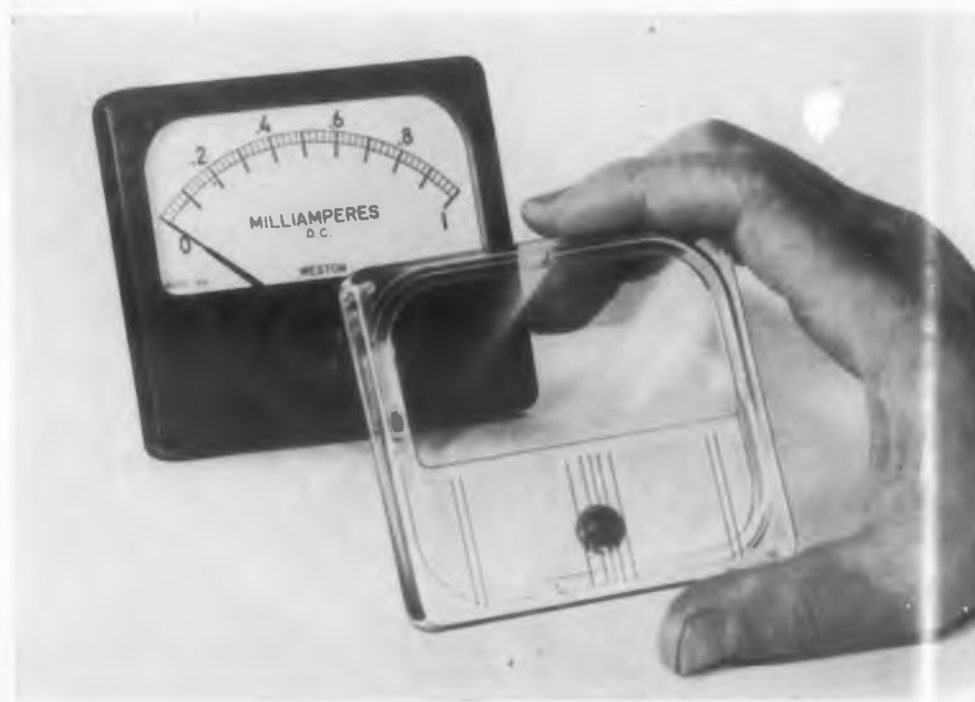
12

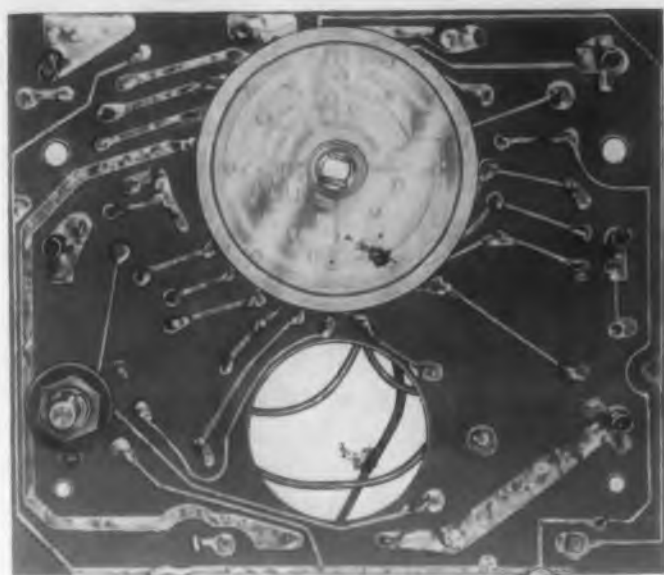


Photos courtesy Weston Electrical Instrument Corp

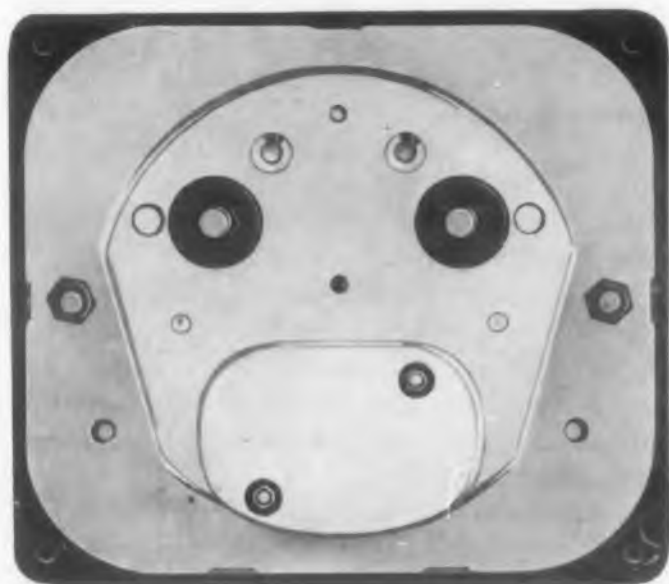


Core magnet employed in meter. At left is shown the two iron shoes and alnico magnet that make up the core magnet. These are assembled and die-cast. At center is shown one end die-cast; at right, both ends have been die-cast. Actual magnet size is 0.580 by 0.600 in. diam. This small core magnet is in sharp contrast with the more conventional meter magnet shown in black and white. Assembly of the large magnet involves a large number of screw fastenings, assembly of a scale glass with clips and screw fastening of the movement to mounting plate. Cost savings in simplifying this arrangement were considerable.





Printed circuit deck (upper left) showing silver-plated switch terminals. A lucite rotor plate is used as shown (left) which holds beryllium-copper moveable contacts. Note that these contacts can be placed in any of a number of positions to take care of any possible switching arrangements. Bosses on the lucite to take the movable contacts have been planned for any future contingency. Shown above is a printed-circuit board with switch rotor in place.



Front and rear views of Model 1331 panel meter showing low cost snap-on feature for the lucite cover. For a black case, the clear cover is spray painted. The rear view shows the alkyd base, speed nuts, and the snap-on cover in place.

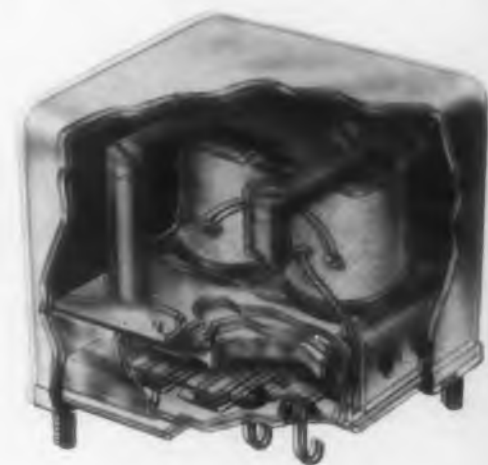
LEACH

SOLVES RELAY ENVIRONMENTAL PROBLEMS

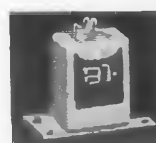
Unique Balanced-Armature Relays meet all requirements of the most exacting operating environments — shock, acceleration, vibration and high temperatures.

In the Leach Balanced-Armature Relay, shock and vibration forces cannot move the relay armature. This eliminates faulty operation of contacts during extreme vibration and acceleration.

These Leach Relays meet or exceed requirements of MIL-R-5757, MIL-R-6106, MIL-E-5272. Typical ratings include: vibration, 20 G's to 500 cps (higher ratings available); shock and acceleration, more than 50 G's; temperature, -50° to $+125^{\circ}$ C; life, 50,000 continuous operations minimum at rated load; available 28 vac, 115 vac, 400 cps operation. At right is Leach 9226, 1.49x1.49x1.68 inches.



Leach has gained a unique reputation for creating reliable relays, *custom-tailored* to solve specific circuitry problems. Write for your copy of the Leach Balanced-Armature Relay Catalog.



LEACH CORPORATION
LEACH RELAY DIVISION

5915 Avalon Blvd., Los Angeles 3, California

District Offices and Representatives in Principal Cities of U. S. and Canada

CIRCLE 50 ON READER-SERVICE CARD



The Electronic Designer's Responsibility For Low-Cost Production



Fred F. Richards
Sr. Electronic Producibility Engineer
Temco Aircraft Corp.
Dallas, Tex.

INCREASED competition brings into focus the responsibility for a low cost production item. Where reliability is considered the criterion of good design, serious consideration must also be given to the cost factors. The designer holds the key to the cash drawer! While a poorly conceived, malfunctioning design will not sell at any price, a complicated design will price itself out of the market. It is in this middle ground where we find the serviceable designs within the reach of the customer.

What is a Low-Cost Design?

A low cost design may be defined as one, which over the period of its lifetime, will satisfactorily perform for the least cost when first cost, operating costs, and repairs have been taken into account.

Basic Concepts are the firm foundation of all design. They must rest on a broad base of knowledge and experience if they are to be economical and reliable. The development of this fundamental structure calls for the best talents from a wide variety of fields. With each new device comes new requirements offering a fresh opportunity and challenge to the designer. For example, consider the design process for a piece of airborne radio gear and observe how each step is a factor in determining the cost.

Brain Picking is the initial step. The electrical engineer with his schematic, the mechanical engineer with his packaging requirements, and the installation engineer with his specifications, are assembled to discuss their peculiar problems with the designer and the producibility engineer. At this time the designer must ask questions and insist on explanations until both he and the producibility engineer are thoroughly acquainted with the problems facing them. From the information gleaned from this brain picking session the producibility engineer and the designer will make up a "cheap and dirty" cardboard model in order to better view the conglomerate of ideas. This model must represent the best possible layout and packaging concepts of which these men are capable.

Real Brainstorming gets underway when the engineer staff again assembles to study the model. Now each problem can be seen in relation to other problems. The heat sinks, the gyro, the memory amplifiers are all there. Every change suggested by an engineer or dictated by a specification is evaluated by the entire group, and its effect upon the overall design is weighed. With scissors and masking tape, the model is quickly modified to reflect an agreeable layout and framework within which the designer can develop his ideas.

Design For Production

The Design for Production is now in the hands of the designer who will be identified with the device and who will be responsible for its costs. The basic configuration and concept has been established. It is up to him to incorporate the features which will identify it as a practical low-cost design. A low-cost chassis design is characterized by:

1. A simple chassis which can be broken up on a common leaf, finger or tab brake.
2. Critical tolerances limited to such things as hole patterns for tube sockets.
3. Oversized holes and slots much in evidence.
4. Components which can be removed and replaced without disconnecting other parts.
5. Printed circuits made rectangular in form with all components on one side of the board and dip soldered.
6. An absence of terminal strips.
7. A very minimum of castings, but when essential will not require accurate machining of more than three surfaces.
8. Every electrical connection where it can be easily reached.
9. Color-coded wiring cables which do not pass through holes, but will be clamped to flat surfaces and hinged to permit examination of sub-chassis for "flip-out" panels.

10. Plugs, jacks or terminals will be conveniently located where they may be used without removing shields or structural members.

In all of these items the matter of cost will be determined by the selection of components and the labor consumed. Examine these features more closely.

Simple Chassis Design

The Simple Chassis is often the most difficult to conceive, but is essential if low cost is to be achieved as it is the basic component upon which all others must rest. In Fig. 1 is illustrated a chassis which meets the requirements of the general group. There are three sub-chassis which are removable. Assembly can be subdivided for high-rate production should such be required. Good ventilation of the tubes and components has been accomplished. Wiring can be made by a cable. The chassis is rigid and square so it can slide into a dust cover. It duplicates the lay-out and dimensions of the cardboard model. *It is not a good low-cost design* even though it fills the need in nearly every respect.

High-Cost Factors

But what high-cost factors does the Production Engineer see in the design?

- Gussets, angles, rivets, holes, and more holes.
- The center chassis is bolted to the two end sub-chassis which makes it difficult to remove either.
- 23 different parts must be sheared or cut requiring 48 operations.
- 147 holes to be punched or drilled.
- 8 notching operations and 20 brakes will take more time.
- 30 rivets must be inserted and hammered tightly in place, while jigs are needed to maintain square corners.

Surely some of these operations can be dispensed with, but *there must be a design change* to do it, since production follows the blueprint.

Every possible motion must be eliminated to produce at low cost. The practical minded designer tends to simplify and questions every hole and every brake. He also has a feeling for the problem of the sales department; his design has a certain eye-appeal. In Fig. 2 is a low-cost chassis which meets all the requirements and is interchangeable with the chassis in Fig. 1. There is little doubt as to which design the salesman would rather present to his customer.

Where is the Saving?

Advantages of the re-design (Fig. 2) are:

- No gussets to shear or brake.
- Only 5 parts (since the side panels are interchangeable) requiring 29 shearing operations.
- 57 holes instead of 147.
- 16 notching operations and 26 brakes complete the entire chassis.
- No rivets are used.
- The tolerance problem is largely taken care of

B & A SALES REPORT NO. _____

PLATING


Name _____ Business _____

Home Office Address _____

Plant Locations Covered by this Report _____

Address of _____ Individual Interviewed _____ Position _____

Plant Location (if More than One) _____ Annual Consumption Year _____ N. T. _____ Deliveries _____ Price and F. O. B. Point _____

Joe - 
 These advantages of B&A Lead-Tin Fluoborate are very important for plating electronic components.

Let's point them out in an ad.

CPB

Mr. _____ said that B&A's Lead-Tin Fluoborate bath is far superior for electronic use to other baths (such as Zinc-Tin hot cyanide).

- Reasons:
1. Lead-Tin Fluoborate bath causes no undesirable fumes.
 2. Parts plated in Lead-Tin Fluoborate baths have good shelf life. They have good solderability after storage.

FCH
CPB

Write today for complete technical information on the use of Lead-Tin Fluoborate for plating of electronic equipment. Ask for B&A Bulletin TG-36431.

BAKER & ADAMSON®

Fine Chemicals

GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.



Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Houston • Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Providence • St. Louis • San Francisco • Seattle • Kennewick • and Yakima (Wash.) In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver • Complete stocks carried here.

CIRCLE 51 ON READER-SERVICE CARD

Whenever the circuit Indicates a transformer



get in touch with
Acme Electric

When performance is the major factor in transformer selection your most logical source of supply is Acme Electric. Our engineering department will help design a transformer to the exact requirements of your circuit, with emphasis on performance, and trouble free, long life service. Our manufacturing facilities can supply quantity production quickly, in step with your production requirements.



We can furnish encapsulated transformers in many forms. Such encapsulating is completed in our own plants.



ACME ELECTRIC CORPORATION
9011 WATER STREET • CUBA, NEW YORK

Acme Electric
TRANSFORMERS

CIRCLE 52 ON READER-SERVICE CARD

Design for

LOW-COST PRODUCTION

by the forming of the side panels and assembly jigs are not needed.

■ The mating holes are evenly spaced. Oversized holes or slots can be used in the side panels.

Component Selection affects the cost in several ways, and a good understanding of the overall system is essential if costs are to be kept at a minimum here. There is a tendency on the part of many designers to overdesign and to complicate. Some components are several times more expensive than their counterparts. The price difference may be due to only a few "g's" or a few degrees of temperature. Selection of a more costly relay to operate at 200 C may seem to add reliability, but if working beside a diode which will conk out at 100 C it will never prove it.

Standard mountings and simple configurations make lay-outs more simple while odd shapes may mean the difference between a trim chassis and a many-angled beast. Components should be selected for a good functional balance wherein all parts will meet about the same environmental standards. It only adds to the cost to use parts which are rated above the system requirements.

The Cost To Assemble is a labor cost and is directly tied to the design. Figs. 1 and 2 show the obvious savings in chassis assembly, but even greater savings are to be made by good design from a wiring standpoint. Too often the mechanical designer finds a place to mount each part and then dares the production people to wire it.

Cables which can be prefabricated and dropped in are most desirable but they should be dropped in and not pulled through holes or grommets. Consider the frustration of trying to pull a Christmas tree through the door tip end first. This is the feeling of the production line when a cable goes through a hole.

The positioning of every component determines the routing of the wiring to it. Just the simple act of turning a tube socket 90 or 180 deg can mean the saving of a connection or may allow a wire to be eliminated entirely. It is not possible to arbitrarily place tubes in a neat row and expect the most economical assembly. A great deal of thought must be given to which tube occupies a certain position since this affects both assembly cost and electrical performance.

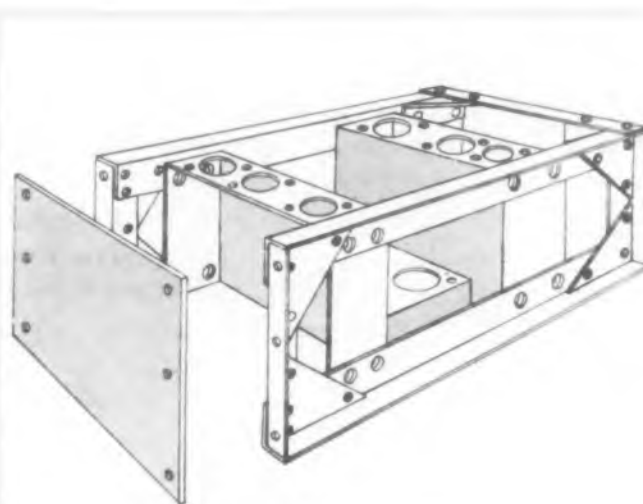


Fig. 1. Functional chassis design—but not necessarily low cost!

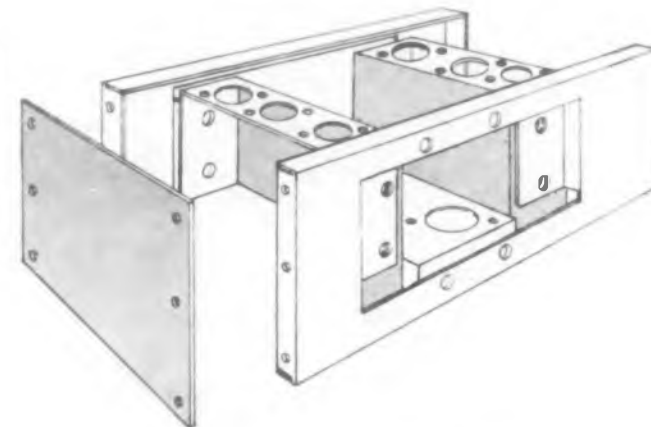


Fig. 2. With costs in mind, this chassis was developed which has the same function as the one illustrated in Fig. 1.

Printed Circuits are often the answer to lowering assembly costs. Whether or not they are adaptable is determined by the peculiarity of the schematic. Where they are used, the components must all be on one side of the board to make dip soldering possible. The circuit must be all on the other side of the board without eyelets. Unless it can be shown that it is easier and cheaper to mount components on a printed circuit board, bore the holes, dip-solder, connect the external leads, etc. than it is to wire the components point-to-point they should not be used just for the sake of having a printed circuit. The problem of repair is often aggravated by printed circuits and should be calculated to determine the cost of parts replacement.

Maintenance and Repairs are part of the life-time cost and often determine the value of a product. Ease of maintenance must be designed into the device. Unless it is possible to remove and replace a part without disconnecting others the service man will soon give the equipment a bad name. The designer who has fought automobile radios during the 1930's or has cussed his way through a tuning cable replacement on an old receiver knows the problem of maintenance. He knows that a man only has two hands—his design won't require three. The check points, jacks and terminal strips will be located where they can easily be reached. The wiring will be color-coded to enable the circuit to be traced visually. Screws and nuts which are located in blind corners or behind structural parts multiply the insertion cost and the maintenance man wastes valuable time when fumbling with them. Screw holding tools or special tools are to be avoided entirely if the maintenance cost is to be kept down.

Tooling Up

So much for the initial model, but how about production units, tooling, etc.?

Special Tooling is necessary only to the extent dictated by the design. The tendency to complicate designs adds to costs in the form of tooling. Electrical designers who are not appreciative of the tool makers problems can greatly increase the cost without being aware of it. The designer whose hands bear the scars of actual shop experience is conscious of the details which require special handling; he strives for simplicity knowing that cost and complication are inseparable.

Watch Volume. The volume to be produced will often dictate the extent to which special tooling is justified. Since the vast majority of designs will see only limited production every effort should be made to make it possible to produce with simple tools. On the other hand an item for defense may be required in great vol-

ume at a moment's notice. The necessity for simple designs is thus accented. In the event a large volume is needed, the simple design could be reproduced in a variety of plants in various sections of the country while the other design was awaiting special tooling. Where a Weideman Turret Punch, a Wales Fabricator, a Whistler set-up, or similar equipments are available all designs should be within the scope of these machines. The cluster dies will hold all critical dimensions for tube sockets, AN connectors and the like. Real savings can be realized by employing these facilities.

Watch Drafting Techniques. Drafting Costs are also affected by the design. Again the elimination of odd contours and artistic curves pays off. In the design shown in Fig. 1 fifteen drawings are required for detail parts plus two for sub-assembly of side panels and one for final assembly making eighteen in all. The design shown in Fig. 2 required only five detail drawings and one for final assembly, a total of six.

Where it is possible to use printed circuits the drawings are basically dimensionless and thus save drafting time. Likewise, printed circuitry reduces the number of drawings to about one half the number required by conventional, point-to-point wiring.

The draftsman must set down every production operation on his blueprint. The designer affects overhead cost in relation to his ability to simplify. A minimum number of parts with straight lines and square corners then becomes an important criterion of low-cost design.

Watch Overhead. Overhead is saved by securing agreement among various engineering groups before any time is used on the drafting board. This is very important since there is always reluctance on the part of management to redesign after having invested in drawings even though improvement would result. The cheap cardboard model, cut with scissors and put together with masking tape can be easily changed during group discussion. It serves admirably to get the production bugs out of the design before money is spent on drawings.

When a designer seeks out and freely accepts the ideas and experience of all those who contribute to the equipment from the cradle to the grave he has the ingredients for success. Therefore, it behooves the designer who would be successful to draw on the bank of experience and information which is his for the asking. Through the incorporation of the most feasible ideas from all those who can contribute plus his own touch of genius he can achieve economy and reliability in design which will automatically put his product out in front and the sales department can go fishin'.

RAYTHEON PANEL COMPONENTS



Color!



For fast visual control identification or for blending with color-styled equipment, Raytheon control knobs are available in standard or special colors. Can be furnished in solid color, or with contrasting colored cap. A complete selection of Braille color cap knobs also available. *Color helps it sell!*



GET FREE DATA
on Raytheon control knobs
by writing to the address
below, Dept. 6120-A



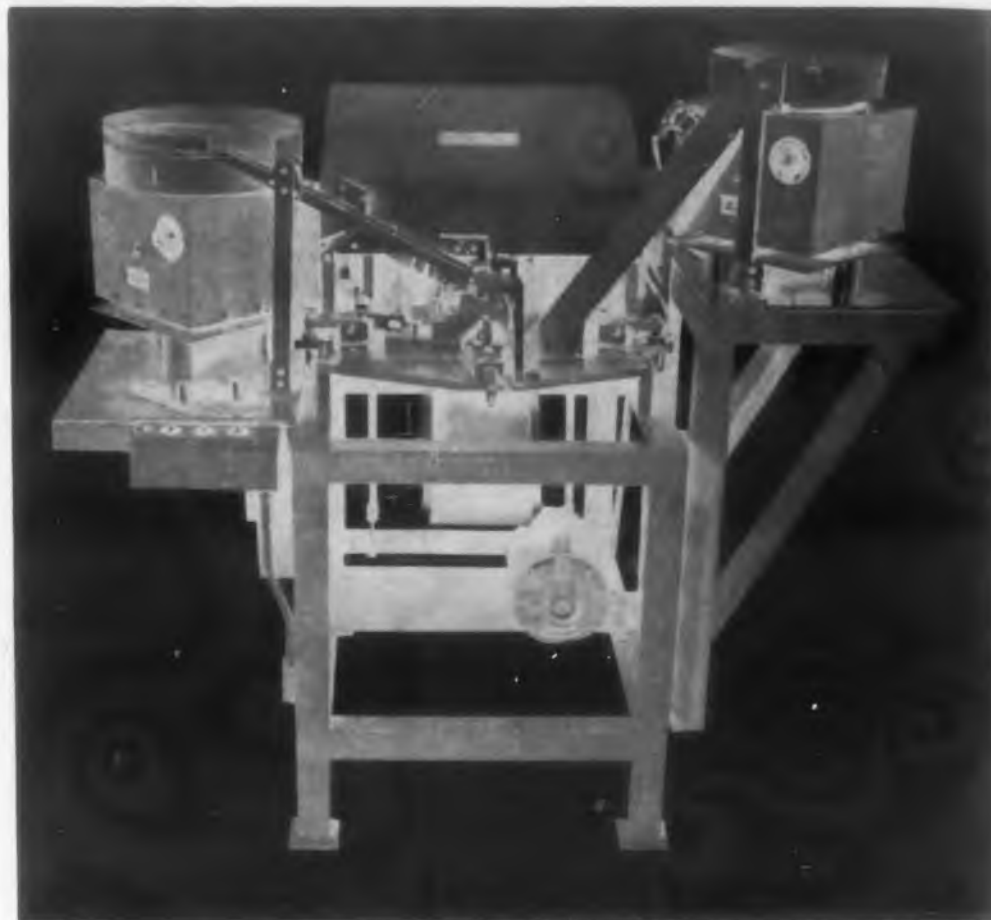
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts
CIRCLE 53 ON READER-SERVICE CARD



Design for
LOW-COST PRODUCTION

Automatic Terminal Capping Machine



Automatic Terminal Capping Machine For Tubular Resistors And Capacitors.

THE AUTOMATIC Capping Machine shown is a fully automatic hopper fed machine designed to assemble externally fitted terminal caps to cylindrical cores or flanged bobbins, such as used in the resistor and capacitor manufacturing industries, at a high rate of speed (3000 assemblies per hour).

While each machine is individually tooled to handle particular sizes of caps and bodies, the basic mechanism is standard. Single machines in many cases can be tooled to handle several sizes by utilizing simple change parts.

Operation

Caps and component bodies are bulk loaded into Syntron vibratory bowls. From this point on, operation is completely automatic. The operator simply presses the start button and the machine feeds caps and bodies.

REX

K-F WIRES

OFFER A NEW STANDARD OF
QUALITY IN HOOK-UP WIRES
FOR 1,000 VOLT SERVICE AT
OPERATING TEMPERATURES
FROM -65°C to 175°C .

To MIL-W-12349 Specifications
Insulated with Kel-F*

MECHANICAL CHARACTERISTICS

- Good abrasion resistance
- Excellent resistance to cold flow
- Extremely flexible
- Smaller O.D. than wires of comparable values

ELECTRICAL PROPERTIES

- Dielectric constant between 2.5 and 3.0
- Good arc resistance
- Zero moisture absorption
- Resists wetting and high humidity

Available from stock in 17 solid colors — AWG sizes 10 through 30, also in 1, 2 or 3 stripes in any combination of 10 colors for almost unlimited color coding. Can also be supplied with braided shielding for special requirements.

Complete facilities for twisting single, insulated conductors in pairs, triplex or quads, cabling 808 conductors into a single core, and, for layer or sector type cabling are available. Application of braided shielding or spiral tape shielding over the core before jacketing a specialty. Jacketing done in polyethylene, vinyl, nylon, or Kel-F.

EFFECTS OF HEAT AGING ON WIRE INSULATED WITH "KEL-F" 500 RESIN

TEMPERATURE AND PERIOD	RMS VOLTAGE BREAKDOWN
Initial Value	13,500
150°C (302°F)	
1 Week	13,000
2 Weeks	14,600
5 Months	12,100
175°C (347°F)	
1 Week	13,500
2 Weeks	14,500
5 Months	5,200
190°C (374°F)	
2 Weeks	9,600

REX - K F

Operating Temperature	175°C to -65°C
Continuous Operating Voltage	1000 volts RMS
Spark Test	7500 volts RMS
Dielectric Strength	5000 volts RMS
Power Factor	.001-.011
Dielectric Constant	2.4-2.8
Insulation Resistance	< 5000meg/1000'
Moisture Absorption	Nil
Flammability	Non flammable
Solvent Resistance	Impervious to corrosive chemicals

Send for complete technical data

*T.M. M. W. Kellogg Co.

ELECTRONICS DIVISION



THE REX CORPORATION

210 Hayward Road
West Acton, Massachusetts

CIRCLE 54 ON READER-SERVICE CARD

The capping operation is accomplished by feeding component bodies from the base of the body chute (right), and transferring them to the capping position. In this position they are positively banked on the O.D. against two fixed surfaces (a 90 deg Vee). While this is occurring, caps are picked up from the base of the cap chute (left), and dropped into the cap rams by two cross slides. When the caps have been seated in the rams, the rams move towards each other and cap the component body. As the rams move back the capped component is stripped and positively ejected downward by the opening of a "trap door." The cycle is then repeated.

All motions are derived from a series of rocker arms which are actuated by a group of cams on the main camshaft. All motions are spring loaded so that in case of jams, damage to the machine cannot result.

The Automatic Capping Machine is designed to handle parts with normal production tolerance variations. Normally the machine will be self clearing in case defective parts are fed to it.

Component Design

This capping machine is suitable for handling resistor or capacitor bodies with a length range of slightly under 1/2 in. to slightly over 2 in. Diameters at the region of cap attachment may range from 3/32 to 5/16 in.

The standard pigtail length of 1-1/2 in. should be maintained to take advantage of the standard cap transfer assembly. Longer or shorter pigtails can be accommodated but these will require special engineering.

Many components originally designed for hand or semi-automatic assembly will not feed satisfactorily into a high-speed automatic machine. Consideration must be given to the necessity of changing the component design in order to take advantage of high speed assembly methods.

A component with a relatively simple geometry such as a film resistor must still be carefully designed to assure a high yield in assembly.

The component body, whether it be ceramic, glass, or plastic should be chamfered at each end at least 0.020 in. to 0.030 in. x 45 deg. The body should be essentially free of visible camber. While length variation need not be held better than $\pm 1/64$ in., the quality of the end is important to provide for ease of escapement from the body chute. The end should be machined square. Pieces broken at score marks tend to break out of square with unpredictable surface configurations. Variations on outside diameter are generally held to ± 0.0005 to ± 0.003 in. depending upon the allowable permissible variation in pressure to the cap.

Caps may be either round or polygonal, solid cups or split. In either case a flare or bell mouth opening works in conjunction with the chamfer on the body to insure smooth entrance of the mating parts. The importance of this flare cannot be overemphasized. A good flare can compensate for normally bad variations elsewhere.

Variations on cap inside diameter are normally held to ± 0.0005 to ± 0.002 in. depending upon the cap material and condition of the forming die.

Straightness of pigtails is not critical if the curvatures are gradual rather than sharp. Modern pigtail attaching machines, when they are properly set up are capable of producing parts that have excellent straightness.

Theoretically, a capping machine will function most successfully if the O.D. of the body always sees the inside of the cap as a target. Actually a certain amount of misalignment is possible if the cap has an L/D ratio of approximately 0.75 or greater. Misalignment will cause a cap to enter tilted, but as it proceeds onto the body it will straighten out provided sufficient clearance in the ram is provided.

The acceptable misalignment should be counted upon to handle the relatively few pieces which fall at the tolerance extremes of a quality controlled part.

An effective quality control program on the piece parts will insure the greatest economic benefit from high speed automatic assembly.

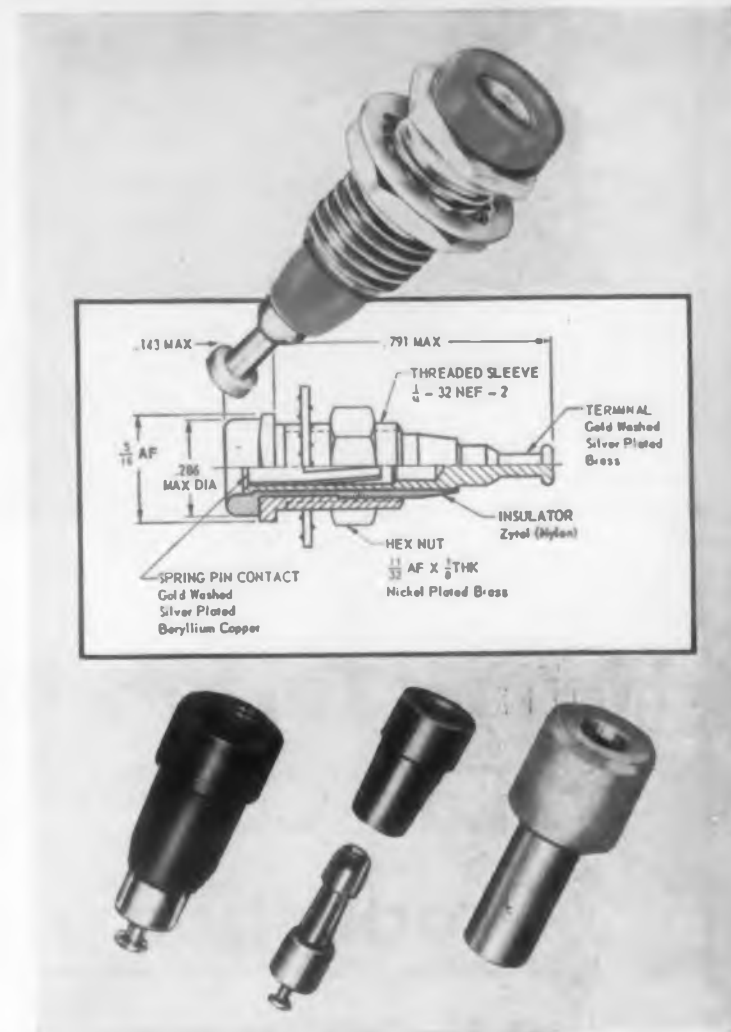
The following variations contribute to reducing the "target" mating area of a component body with respect to its companion press fitted caps in a high speed assembly machine.

	Variation in	Normal Acceptable Limits
Body	Outside Diameter	$\pm .0005$ to $\pm .003$ in.
	Length	$\pm 1/64$ in.
	Squareness of Edge	No feathers
	Camber	Not readily ascertainable visually
Caps	Chamfer	.020 to .030 in. x 45 deg.
	Flare	Depends on amount of body chamfer
	Pigtail Length	$\pm 1/32$ in.
	Pigtail Straightness	Avoid crushing when handling manually
	Inside Diameter	$\pm .0005$ to $\pm .002$ in.

An appreciation of the above mentioned variables and their possible statistical combinations will assist in taking full advantage of readily available high speed automatic assembly equipment. Attention to detail at the inception of component design will save costly retooling and reworking.

For more information write Halm Instrument Co., Inc., Special Products Div., Dept. Ed, Glen Head, L.I., N.Y., or turn to the Reader Service Card and circle 422.

RAYTHEON TEST JACKS



Contact!

Raytheon's sure-contact test jacks—standard, printed-circuit, and subminiature types—are ruggedly built, have passed gruelling tests. Exclusive beryllium-copper spring-pin contacts insure smooth prod insertion, low contact resistance throughout long life. Nylon insulators available in 9 colors.

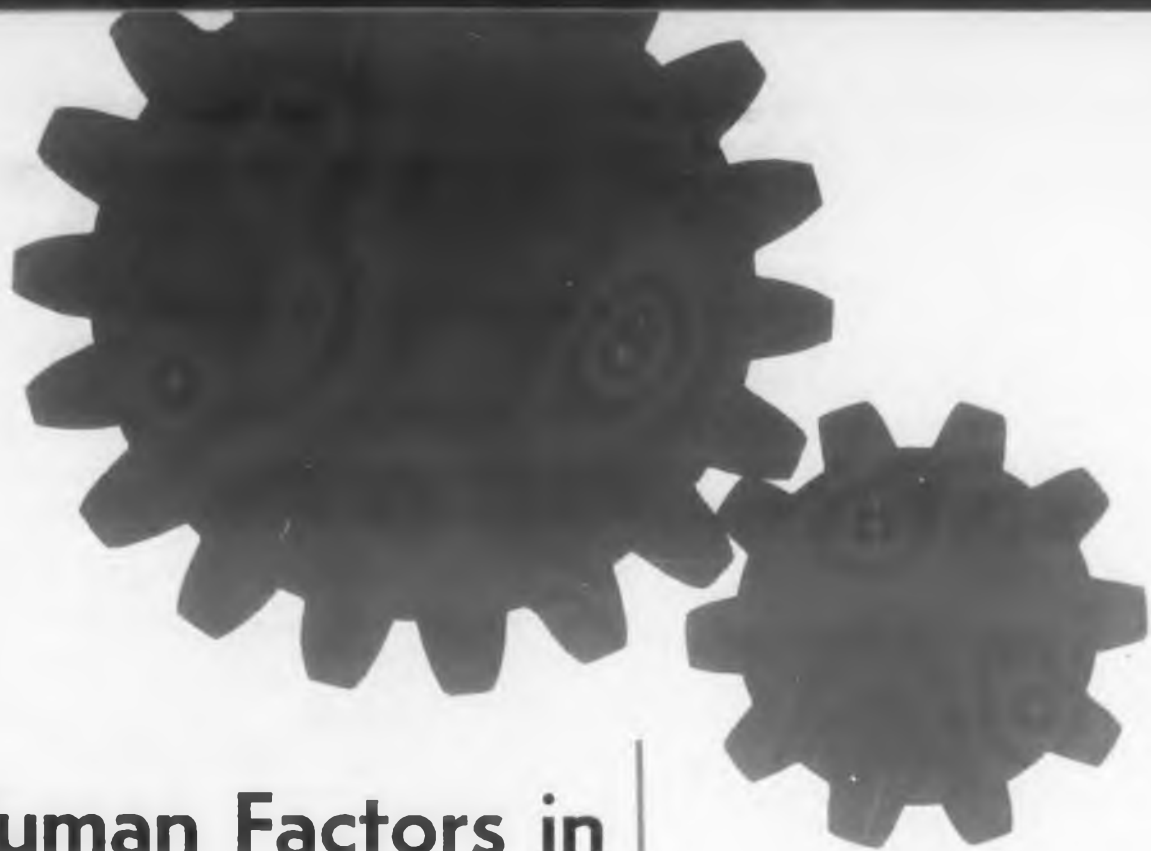


Send for **FREE Booklet** on Raytheon's line of advanced-design test jacks. Please write to Dept. 6120-C at address below.



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts
CIRCLE 55 ON READER-SERVICE CARD



Design for LOW-COST PRODUCTION

Human Factors in Low-Cost Production

CONSIDERATION of the human elements in production line assembly by Applied Psychological Services has brought about increased production for the Ballistic Missiles Division of the Burroughs Corporation. For example, in the interest of conserving space, the space between the cores in the programmer of one computer was to be minimized. The question, "What is the minimum space that can be allowed between cores without prejudicing wiring time and error frequency?" became apparent. The proposed core tray design was "mocked-up" with the exception that the "mock-up" was made flexible for varying the distance between cores and an experiment set up to determine the minimum acceptable spacing. Actual wiring personnel were used as subjects. It was found that considerable variation among wiring personnel existed in regard to wiring speed and error frequency and that a considerable savings could be introduced by a more proper selection procedure. It was further found that a one-inch spacing between cores decreased wiring time over a 7/8 in. spacing by approximately 5 per cent with no increase in error frequency. A 1-1/8 in. spacing did not decrease wiring time to a statistically significant extent over the one-inch spacing. Accordingly the one-inch spacing was adapted. *From information supplied by Arthur Siegel, Director, Applied Psychological Services, Villanova, Pa.*

Standardization and Cost

STANDARDIZATION is an important consideration because it tends to result in the best overall design by selection of the most suitable size, quality, method, procedure or process etc., so that the most efficient utilization of the resources of men, materials, machines, money and time are realized. To meet the requirements of standardization an item must be sufficiently universal in its characteristics to permit wide usage, and must be capable of serving as a possible substitute for as many like components as is consistent with the results to be accomplished.

In the design of a given product, the ready availability of materials, the applicability of commonly used shop methods, and the simplicity of any necessary special components must be considered to be of prime importance, whether that product be a complex electronic device or a simple dime-store can opener. Standardization produces the following results which are almost immediate in their effect:

In Engineering—

- Elimination of duplication in work and research through the re-use of past items, systems and experience.
- Improvement in quality.
- Increased capacity.

In Production—

- Saving in time and money through proper utilization of procedures, experience, facilities.
- Simplification of mass production.

In Procurement—

- Simplification of procurement through improved availability and process.
- Reduction in the number of different items of stock necessary to be procured and maintained.
- Reduction in the amount of capital required to maintain stock.

Customer Relations—

- Benefit to the customer deriving from lower first cost.
- Benefit to the customer as a result of simplified maintenance and reduction in number of spare parts required for stock.

The Manufacturer—

- Improvement in competitive position resulting from each of the benefits cited above.

It is mandatory for engineering personnel to make use of existing standards, methods, facilities, and procedures and employ standard components whenever and wherever possible.

*From information supplied by personnel of the
Technical Products Div., Allen B. DuMont Labs., Inc.*

Decreasing the Cost of Instruction Manuals

Paul Billick

Chief Engineer
Aabab Enterprises
Red Bank, N. J.

WITH present-day equipment continuously increasing in complexity, the need for complete technical coverage in the accompanying instruction manual is becoming more and more obvious. The high cost of producing good technical literature can be kept to a minimum if the following points are carefully considered.

1. Who will be the user of this literature?
2. Who will repair this device?
3. Who will print the literature? Must color be used? Are foldouts necessary? What is the lowest-cost type of printing that is acceptable?
4. Who will do the writing?
5. Who will do the art and drafting?
6. Who will do the "dog work?"

Each of the above six items can lead to a maze of complexities.

Keep Purpose in Mind

The first thing to think about for each piece of literature is "What is its purpose?" When describing a frequency standard for instance, the explanations are quite different to a qualified radio engineer than to a partially trained military inductee. Where more than one level of user exists, sufficient write-up for the lower level is needed. Obviously, in the case of the radio engineer, input and output connection procedures may be left sketchy and general and on-and-off switches, unless unduly complicated, need not even be mentioned. *Save* by including only necessary information.

What Is Reader's Background?

It is very important to consider the technical knowledge and training of the person who is going to do the actual repair work. For military purposes, the maintenance section of the instruc-

tion manual becomes long and detailed. All removable parts are "called out" and high quality art and drafting standards must be adhered to. For qualified civilian laboratory technicians, only special alignment details need be given. *Save* by including only necessary information.

Saving Printing Cost

Whether printing can be done in the "home shop" or whether it would be cheaper and more expeditious to "farm it out," must be determined. Color is expensive and not all print shops can do it. Rule it out unless the gain in technical understanding or advertising value makes it worthwhile. Foldouts are costly and require special handling—try splitting the drawing onto two opposing pages. Do not use typesetting if a mimeographed brochure will do, etc.

Select Writer with Care

The actual writing takes time. Unless your firm has a writing department, making up the manuscript can take up a lot of time for some capable engineer. If the job is given to some clerk, the engineer still loses time because of the questions he is asked. Usually, a professional technical writer will do the job at the least cost.

"Farm Out" the Art

If the company Art and Drafting departments cannot do the required quality or quantity of work, it is fairly simple to farm this out. Remember that Government standards are high—thereby much more costly than average. Don't underbid. Most art work must be retouched; this is expensive, so don't assume that a good photo is all that is required.

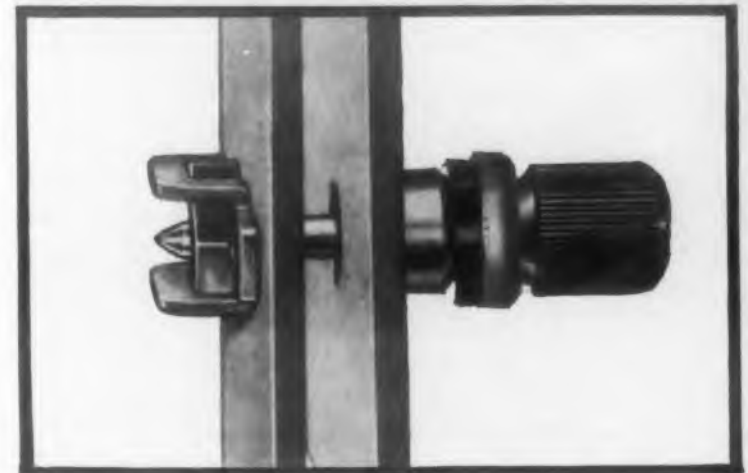
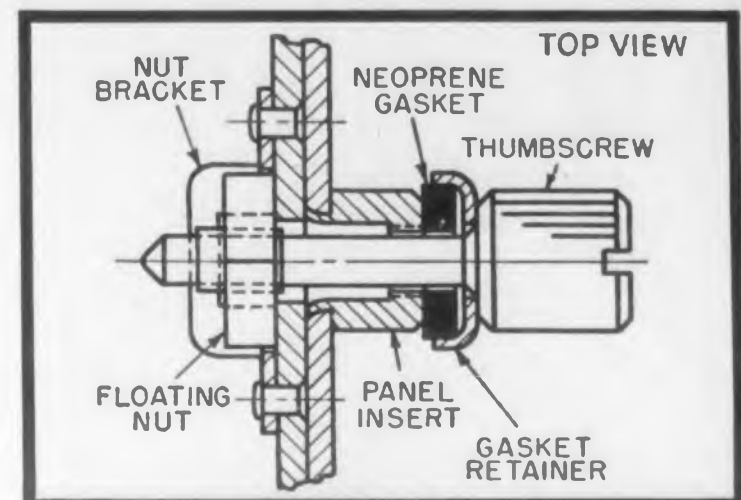
Preparing the Manuscript for Production

There is a considerable amount of time consumed, during the production of literature, in "lower grade work." Someone must retype draft manuscripts. They must be given a literary edit—most writing firms have ex-English teachers do this. There is a final typing and proofreading; also galleys to check. Reproduces must be kept track of and the final job must be collated and assembled. Finally, there is packaging and shipping to consider.

Practically all of the above six items are taken care of by a professional writing service. However, the technical capabilities vary, so make a thorough investigation before hiring any of them. Jobs that are to consist of a few pages can best be written at the home company. After the manuscript is prepared, give it to someone else and see if he can follow the instructions.

Remember that only that information that is really required should go into the manuscript. Anything extra runs up the cost—with no returns.

RAYTHEON MECHANICAL COMPONENTS



Closure!

Fast, easy access — simple, firm closure... assured by this unique captive closure hardware.

No fumbling with loose nuts, screws or bolts. Convenient panel thumb screw lines up automatically with captive nut on rack or cabinet. Neoprene gasket seals against dirt and moisture. A variety of standard sizes available from stock. Designed in accordance with government specifications.



COMPLETE DATA
on captive hardware and other Raytheon mechanical components. Please write to Dept. 6120-F at the address below.



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts
CIRCLE 418 ON READER-SERVICE CARD



Sheet Metal Design

S. A. DeCosmo

Allen B. DuMont Labs.,
Clifton, N. J.

MECHANICAL and sheet metal design is often erroneously subordinated to electrical considerations in the electronic industry. This is unfortunate, since sheet metal design and mechanical design require the same level of engineering approach as is employed in electronic design. An equipment characterized by a well designed electrical system may be designated inferior by a prospective user if the mechanical components are of indifferent design. Since mechanical or sheet metal parts cannot thus be regarded as an unimportant part of the overall consideration in the design of electronic systems, some attention must be directed to sheet metal manufacturing methods and procedures.

Sheet metal parts are subject to several methods of fabrication: shearing; routing; sawing; blanking; forming or bending; and welding-spot or fusion.

A short description of accepted manufacturing methods used in the sheet metal industry and a series of charts and tables covering each of the above headings, are shown to aid in the better design of mechanical sheet metal parts.

Blanking and Piercing

When quantities exceed approximately 1000 parts, blanking represents the quickest and most economical means of cutting flat sheet to any specified contour. Blanking is generally employed in large quantity production or in instances where the required contour of the part prevents the use of an alternate method, such as sawing or routing. Piercing is that operation which involves removal of material from the part being processed (as opposed to blanking, which refers to the operation on a part cut out of the material). Both are generally performed by putting the material in a punch press; a punch is mounted on the reciprocating head of the press and is rammed through the material into a mating die fixed on the bed of the machine.

Wherever possible, parts fabricated by blanking or piercing should provide for the following:

- Generous internal and external radii. Dies with sharp corners are generally difficult to manufacture and maintain; ample radii represent a precaution against cracking and fatigue of tools.
- The use of as many identical pierced holes as

possible, in order to reduce the number of different dies required. This is especially desirable in small quantity production.

- Generous part tolerances, since tool tolerances must be held to 1/2 of the engineering tolerances to be specified.

In general, standard holes and notches should be used wherever possible. Non-standard holes can sometimes be produced by multiple stamping operation through the use of smaller dies; however, this procedure should not be resorted to indiscriminately.

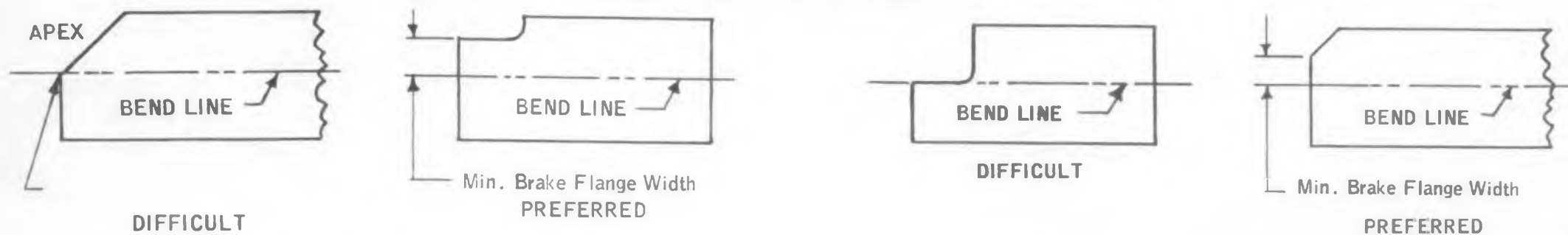
Sawing

Sawing is generally used for rough cutting of parts and does not readily lend itself to high quantity production. About 500 parts are considered to be the maximum economical number that should be expected from a sawing operation.

Routing

Routing is an economical and rapid means for profiling, making cutouts, and trimming sheet metal parts up to quantities of 100. Aluminum

Fig. 1. Brake Forming Suggestion



DIFFICULT

Bending at an apex of an acute angle is difficult. A small flange is preferred.

DIFFICULT

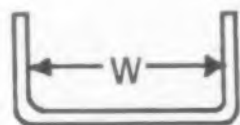
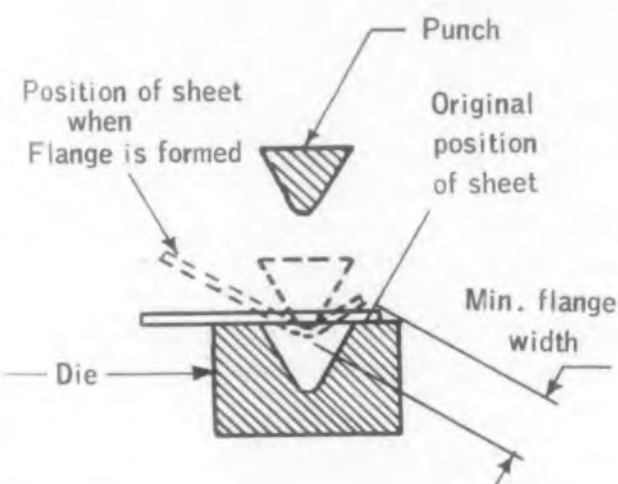
Bend lines near edges of cutouts are extremely difficult to bend due to lack of gripping surface in the cutout area. A flange will facilitate bending.

Min. Brake Flange Width
PREFERRED

Table 1A. Minimum Flange Width (inches) for Aluminum Alloy

Bend Radii (inches)	Metal Gauge													
	.016	.020	.025	.032	.040	.051	.064	.072	.081	.091	.102	.125	.156	.188
0 - 1/16	.31	.31	.31	.31										
1/4 - 3/32		.31	.31	.31	.31									
1/4 - 1/8		.31	.31	.31	.31	.31								
1/4 - 5/32			.31	.31	.31	.32	.33	.36						
1/4 - 3/16	.36	.36	.36	.37	.38	.39	.40	.44	.46	.48				
1/4 - 7/32			.46	.47	.48	.49	.50	.51	.52	.53	.54			
1 5/64 - 1/4			.47	.48	.49	.50	.51	.52	.53	.54	.55	.62		
1 7/64 - 3/16				.50	.52	.55	.57	.59	.60	.62	.64			
1 1/32 - 3/8				.61	.62	.63	.64	.65	.68	.69	.70	.91		
2 5/64 - 7/16				.67	.68	.69	.87	.90	.92	.94	.95	.96		
2 9/64 - 1/2				.92	.94	.95	.98	1.00	1.01	1.02	1.05	1.07	1.15	
3 3/64 - 17/32											1.08	1.10	1.18	
3 5/64 - 21/32												1.22	1.29	
4 3/64 - 25/32														1.41

Values above heavy lines are for SO aluminum alloy only; values below heavy lines are for both SO and ST aluminum alloy; if values being determined are for ST aluminum alloy and the bend radius involved is above the heavy line, use the first value below the heavy line for the gauge affected.



The minimum web width "W" is equal to 3/4 in. or 2 times the minimum flange whichever is greater. Parts having web width less than "W" should not be considered for forming on the power brake.

Sheet Metal Design Tips

- In designing cabinets and similar related parts, avoid individual mounting blocks which must be welded in position since in the welding operation the sides of the cabinet bow either in or out depending on the stresses caused by the heat of the welding operation. In addition, tolerances are difficult to maintain. A recommended remedy for this condition would be to create a hat section, locating the mounting holes prior to the tack welding operation.
- When bend relief notches can remain visible after fabrication, it is more economical to do so since the additional filling operation is eliminated.
- When necessary to provide grounding for sliding chassis, use stainless steel wherever possible, for the flanges rather than cadmium plated steel. In the spot welding operation the welding tips are rapidly destroyed and the cost of the tips is far more expen-

sive than the initially higher cost of the stainless.

- Anti-vibration fasteners should not be used except where vibration conditions require them. It is wise to investigate some other means of providing fastening. For example, extrusions and tapping of the basic material were determined to be approximately 2/3 the cost of A-V fasteners. This process of course has its disadvantages; one is that it cannot be very close to any bend line, the other is that the hole must be tapped after plating.

- Careful consideration should be given to the overall sizes of special panels in order to minimize the waste when shearing from standard mill sheets. On large chassis, which involve a non-standard mill sheet size, the cost of the waste can be great. A possible remedy would be to break up one chassis and make two out of it. Also, savings could be realized in some instances if the wasted material was specified to be returned to the supplier.

RAYTHEON VOLTAGE REGULATORS



Steady!

The life and operation of your equipment need not be affected by ups and downs in line voltage. Whether your line is 95 or 130 volts, the Raytheon voltage regulator will supply rated output within $\pm 1/2\%$. Response is within 1/20 second. Standard units from 15 to 2,000 watts; specials from 5 to 10,000 watts.



FREE LITERATURE giving ratings and physical dimensions. Please write Dept. 6120G, address below.



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts

CIRCLE 56 ON READER-SERVICE CARD



Sheet Metal Design

S. A. DeCosmo

Allen B. DuMont Labs.,
Clifton, N. J.

MECHANICAL and sheet metal design is often erroneously subordinated to electrical considerations in the electronic industry. This is unfortunate, since sheet metal design and mechanical design require the same level of engineering approach as is employed in electronic design. An equipment characterized by a well designed electrical system may be designated inferior by a prospective user if the mechanical components are of indifferent design. Since mechanical or sheet metal parts cannot thus be regarded as an unimportant part of the overall consideration in the design of electronic systems, some attention must be directed to sheet metal manufacturing methods and procedures.

Sheet metal parts are subject to several methods of fabrication: shearing; routing; sawing; blanking; forming or bending; and welding-spot or fusion.

A short description of accepted manufacturing methods used in the sheet metal industry and a series of charts and tables covering each of the above headings, are shown to aid in the better design of mechanical sheet metal parts.

Blanking and Piercing

When quantities exceed approximately 1000 parts, blanking represents the quickest and most economical means of cutting flat sheet to any specified contour. Blanking is generally employed in large quantity production or in instances where the required contour of the part prevents the use of an alternate method, such as sawing or routing. Piercing is that operation which involves removal of material from the part being processed (as opposed to blanking, which refers to the operation on a part cut out of the material). Both are generally performed by putting the material in a punch press; a punch is mounted on the reciprocating head of the press and is rammed through the material into a mating die fixed on the bed of the machine.

Wherever possible, parts fabricated by blanking or piercing should provide for the following:

- Generous internal and external radii. Dies with sharp corners are generally difficult to manufacture and maintain; ample radii represent a precaution against cracking and fatigue of tools.
- The use of as many identical pierced holes as

possible, in order to reduce the number of different dies required. This is especially desirable in small quantity production.

- Generous part tolerances, since tool tolerances must be held to 1/2 of the engineering tolerances to be specified.

In general, standard holes and notches should be used wherever possible. Non-standard holes can sometimes be produced by multiple stamping operation through the use of smaller dies; however, this procedure should not be resorted to indiscriminately.

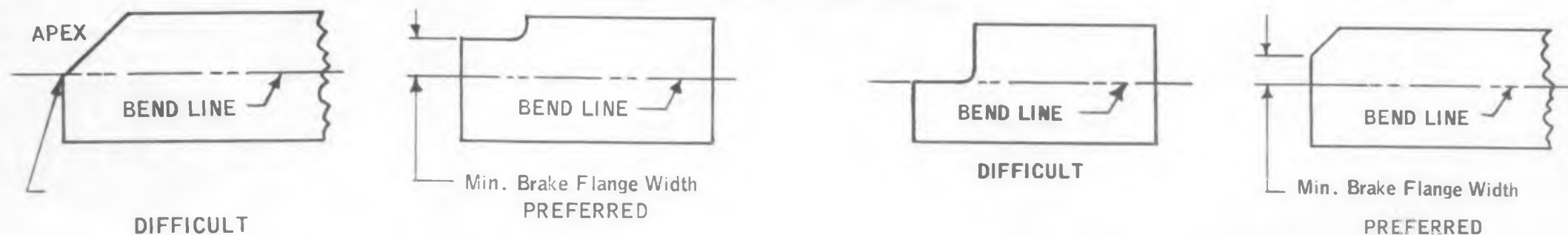
Sawing

Sawing is generally used for rough cutting of parts and does not readily lend itself to high quantity production. About 500 parts are considered to be the maximum economical number that should be expected from a sawing operation.

Routing

Routing is an economical and rapid means for profiling, making cutouts, and trimming sheet metal parts up to quantities of 100. Aluminum

Fig. 1. Brake Forming Suggestion



DIFFICULT

Bending at an apex of an acute angle is difficult. A small flange is preferred.

DIFFICULT

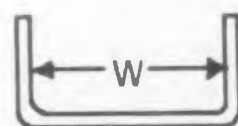
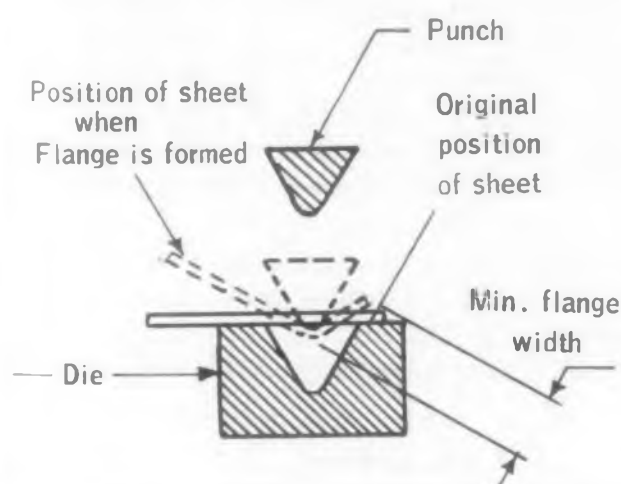
Bend lines near edges of cutouts are extremely difficult to bend due to lack of gripping surface in the cutout area. A flange will facilitate bending.

Min. Brake Flange Width
PREFERRED

Table 1A. Minimum Flange Width (inches) for Aluminum Alloy

Bend Radii (inches)	Metal Gauge														
	.016	.020	.025	.032	.040	.051	.064	.072	.081	.091	.102	.125	.156	.188	
0 - 1/16	.31	.31	.31	.31											
1/64 - 3/32		.31	.31	.31	.31										
1/64 - 1/8		.31	.31	.31	.31	.31									
1/64 - 5/32			.31	.31	.31	.32	.33	.36							
1/64 - 3/16	.36	.36	.36	.37	.38	.39	.40	.44	.46	.48					
1/64 - 7/32			.46	.47	.48	.49	.50	.51	.52	.53	.54				
1/64 - 1/4			.47	.48	.49	.50	.51	.52	.53	.54	.55	.62			
1/64 - 3/8				.50	.52	.55	.57	.59	.60	.62	.64				
1/32 - 3/8				.61	.62	.63	.64	.65	.68	.69	.70	.91			
25/64 - 7/16				.67	.68	.69	.87	.90	.92	.94	.95	.96			
25/64 - 1/2				.92	.94	.95	.98	1.00	1.01	1.02	1.05	1.07	1.15		
25/64 - 17/32											1.08	1.10	1.18		
25/64 - 21/32												1.22	1.29		
45/64 - 25/32														1.41	

Values above heavy lines are for SO aluminum alloy only; values below heavy lines are for both SO and ST aluminum alloy; if values being determined are for ST aluminum alloy and the bend radius involved is above the heavy line, use the first value below the heavy line for the gauge affected.



The minimum web width "W" is equal to 3/4 in. or 2 times the minimum flange whichever is greater. Parts having web width less than "W" should not be considered for forming on the power brake.

Sheet Metal Design Tips

- In designing cabinets and similar related parts, avoid individual mounting blocks which must be welded in position since in the welding operation the sides of the cabinet bow either in or out depending on the stresses caused by the heat of the welding operation. In addition, tolerances are difficult to maintain. A recommended remedy for this condition would be to create a hat section, locating the mounting holes prior to the tack welding operation.
- When bend relief notches can remain visible after fabrication, it is more economical to do so since the additional filling operation is eliminated.
- When necessary to provide grounding for sliding chassis, use stainless steel wherever possible, for the runners rather than cadmium plated steel. In the spot welding operation the welding tips are rapidly destroyed and the cost of the tips is far more expensive than the initially higher cost of the stainless.

- Anti-vibration fasteners should not be used except where vibration conditions require them. It is wise to investigate some other means of providing fastening. For example, extrusions and tapping of the basic material were determined to be approximately 2/3 the cost of A-V fasteners. This process of course has its disadvantages; one is that it cannot be very close to any bend line, the other is that the hole must be tapped after plating.
- Careful consideration should be given to the overall sizes of special panels in order to minimize the waste when shearing from standard mill sheets. On large chassis, which involve a non-standard mill sheet size, the cost of the waste can be great. A possible remedy would be to break up one chassis and make two out of it. Also, savings could be realized in some instances if the wasted material was specified to be returned to the supplier.

RAYTHEON VOLTAGE REGULATORS



Steady!

The life and operation of your equipment need not be affected by ups and downs in line voltage. Whether your line is 95 or 130 volts, the Raytheon voltage regulator will supply rated output within $\pm 1/2\%$. Response is within 1/20 second. Standard units from 15 to 2,000 watts; specials from 5 to 10,000 watts.



FREE LITERATURE giving ratings and physical dimensions. Please write Dept. 6120G, address below.



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts

CIRCLE 56 ON READER-SERVICE CARD

Table 1B. Minimum Flange Widths for SAE 4130 Steel, Normalized

Bend Radii	Gauge									
	.025	.036	.050	.063	.080	.100	.125	.160	.187	.250
0 - 1/32	.187									
1/16	.187	.187								
3/32	.218	.250	.250							
1/8		.281	.312	.343	.406					
5/16			.375	.421	.437	.515				
1/4				.468	.500	.546	.625			
3/8					.562	.578	.687	.750		
1/2						.750	.875	.906	1.062	
3/4							.937	.968	1.062	1.375

Table 1C. Minimum Flange Widths for SAE 4130 Steel, Annealed

Bend Radii	Gauge									
	.025	.036	.050	.063	.080	.100	.125	.160	.187	.250
0 - 1/32	.187									
1/16	.187	.187								
3/32	.187	.234	.250							
1/8		.250	.312	.343						
5/16			.312	.343	.406					
3/8				.328	.343	.421	.468			
1/2					.421	.437	.500	.593		
5/8						.468	.500	.531	.625	.718
3/4							.562	.578	.687	.750
7/8								.750	.796	.812
1									.812	.968
1 1/8										.968
1 1/4										1.093

Table 1D. Minimum Distance Between Adjacent Sheet Metal Bends

Metal Gauge	Length "A" (in.)
.000 - .040	1 1/32
.041 - .072	1 1/16
.073 - .125	1 1/4



alloy, magnesium, copper and brass are the metals most generally routed. Steel sheet is not satisfactorily routed.

Routing is generally limited for application to parts having an internal radius of 5/32 in. or greater and with an external radius of 1/16 in. or greater.

Shearing

Shearing is employed as a means for sizing parts with straight line external cuts. This is the most common method of sizing regularly shaped sheet metal blanks in quantities up to 1000.

Forming

Forming operations are accomplished by several different methods, depending upon the contours of the parts being fabricated. The two major classifications of forming operations embrace problems involving simple bends around one axis and the stretching or drawing of metals around compound curves, respectively.

Simple bends around one axis may be effected on a power brake or in a rolling mill. The power brake is used to fabricate a majority of open ended parts, such as angles and channels; stretching or drawing operations are performed on stretch presses, punch presses, and drop hammer presses.

Forming Designs to Aid Production

It will be recognized that the forming of simple bends around one axis is the most uni-

versal forming operation. A detailed description of the limitations of this process is presented herein in the form of charts and tables showing some of the more important minimum values for flange widths, bend radii and offsets or joggles; these criteria have been derived empirically in the sheet metal industry. Table IA shows minimum flange width VS bend radii for aluminum alloy SO and ST. Tables 1B and 1C show the same for steel, normalized and annealed, respectively. In Table 1D is shown minimum recommended distances between bends. Forming suggestions are shown in Fig. 1.

Table II is a listing of recommended minimum bend radii for various metals. These tables are based on not exceeding the ultimate fibre stresses of the material during the bend. Through general practice it has been found that an elongation of more than 12 per cent will produce cracking of the material. Slightly greater freedom is permissible for non-structural parts as shown in Table IID. Table III shows a set of values recommended from practice for standard offsets in use by the sheet metal industry.

Welding Practices

The two most popular general types of welding are non-pressure and pressure welding.

Non-pressure Welds

For Thin Gage Sheet non-pressure welding includes the processes of arc and gas welding. Gas welding is the oldest form of welding currently

in use, and it may be used successfully wherever welding is indicated. While it tends to be slower and to produce more warpage than arc welding, it is the only non-pressure process suitable for welding of thin gage sheets.

For Tensile Strength, arc-welding is a high speed process which is employed where strength requirements are high. The concentrated heat zone of the parent metal reduces the effects of warpage caused by the welding process. Generally speaking, arc-welding of alloy steel requires a strain relieving treatment; pre-heating is required on alloy steels, especially on thin sections.

Pressure Welds

A widely used form of pressure welding is resistance welding, and included in this classification are spot welding, seam welding and flash welding.

For Shear Strength, most resistance welds are considered to be ideal for transmitting shear loads, but poor for transmitting tension loads. Resistance welding is a production process and represents a fast and economical solution when the design application involved is suitable.

Due to the difficulty of evaluating by visual means the soundness of weldments, and due also to the wide variation in operating conditions in many welding shops, the designer should exercise caution in his choice of welding as a method of joining components into an assembly. In consideration of the best compromise between good engineering practice and existing procurement

problems, a specification for welding requirements should be written which adequately covers the requirements of sound design and yet allows some freedom of procurement. Usually, government welding specifications can be met by most responsible fabrication shops; it is the duty of the purchasing and inspection departments to locate and evaluate suppliers who can meet these requirements. With the assurance that fabrication will meet specifications, it is then possible for the designer to employ welding in those places where it will permit optimum design at the smallest cost.

Further, information should be made available to the designer which will indicate to him the size and shape limitations of the parts which can be fabricated on the various types of equipment available in the supplier's shop.

Cost Analysis

Sheet metal costs go up mainly because of high tooling cost, complexity of piercing and forming operations, extreme requirements on strength or ruggedness, tight tolerances, improper material selection, tight bend radii, or too narrow flanges.

Cost of Tooling

The use of any special tooling should be avoided since it is extremely expensive. For example: A capacitor has a hole cluster which includes three rectangular slots arranged around one central clearance hole. This carries a tool charge of \$180 per set. It has been determined that based on a quantity of 300 units, five die

sets would have to be included (\$900) in the cost of these units. A remedy for this situation would be to use the standard mounting plate supplied. Tools of this type, if they must be used, should not be utilized where the material thickness exceeds 0.047 in. since 20 per cent greater pressure or more must be exerted, and die life is considerably shortened.

Complexity of Piercing and Forming Operations

Hole and cutout locations should not be placed too close to any bend line (refer to the minimum bend allowance charts)—because the forming or bending operation tends to pull the hole out of round and will distort any cutout. The only way to overcome this problem is to drill the hole and file the cutout after the forming operation thus adding an extra and costly operation. Hole diameters less than the material thickness should not be used since these holes must be drilled instead of pierced and are therefore more costly.

Specify Proper Welding Process

Spot welding has been determined to be the most economical method of chassis fabrication since in seam welding a clean-up operation is required to provide a neat appearance and in order to obtain a good paint finish. To specify for spot welding, however, certain fundamentals must be considered: (Refer to Standard Aluminum Reference Book)

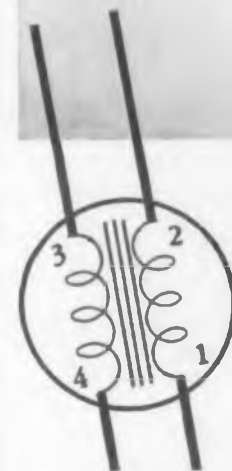
For Aluminum—

- Minimum edge distance
- Minimum spot spacing

Table 2A. Minimum Bend Radii (in.) for Aluminum Alloy Parts Formed on Power Brake

Gauge	75S		14S Alc.		24S Alc.		61S		52S
	0	T6	0	T6	0	T3&T4	0	T6	0
.016	3/4	9/4	5/4	7/4	5/4	5/4	5/4	7/4	5/4
.020	7/4	9/4	5/4	7/4	5/4	5/4	5/4	7/4	5/4
.025	7/4	9/4	5/4	7/4	5/4	5/4	5/4	7/4	5/4
.032	7/4	9/4	5/4	1/8	5/4	5/4	5/4	7/4	5/4
.040	7/4	3/2	5/4	1/8	5/4	7/4	5/4	7/4	5/4
.051	1/8	3/16	5/4	9/4	7/4	7/4	7/4	1/8	7/4
.064	9/4	1/4	7/4	3/16	1/8	3/2	7/4	3/16	7/4
.072	9/4	2 1/4	7/4	1/4	9/4	3/16	7/4	3/16	7/4
.081	9/4	2 1/4	7/4	2 1/4	3/16	1/4	1/8	1/4	1/8
.091	3/16	2 9/4	7/4	2 1/4	3/16	3/16	1/8	1/4	1/8
.102	3/16	2 9/4	1/8	2 3/4	1/4	2 3/4		3/16	
.125	3/16	5/8	9/4	1/2	1/4	2 9/4	3/16	3/8	3/16
.156	2 1/4		3/16		2 1/4	1/2	1/4		1/4
.188	2 3/4		1/4		1/2	2 1/2	2 1/4		

RAYTHEON TRANSFORMERS



Shape!

This unique spherical pulse transformer (designed for blocking oscillator) measures just 3/4 inch in diameter. It was developed to meet a customer's special space requirements without sacrificing electrical performance. Special configurations and sizes are no obstacle to Raytheon transformer design engineers. Let them tackle your problem.



FREE DATA SHEETS:

Please write to Dept. 6120-D, address below stating requirements.



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts
CIRCLE 57 ON READER-SERVICE CARD

NEW

"FEATHER TOUCH"

PUSH-BUTTON SWITCH



**UNIMAX
Type 2MJK**
Provides ultra-fast
repeat action —
"typewriter touch"

SWITCH
SHOWN
ACTUAL
SIZE

- **Operate force** — 2 oz., approx.
- **Total Travel** — 1/4 inch.
- **Plunger keyed** to prevent rotation
- **Two Unimax subminiature switches** provide DOUBLE-POLE, DOUBLE-THROW action.
- **For 4-Pole, DOUBLE-THROW action** specify Unimax type 4MJK, which is furnished also with operate force of two ounces, approx.
- **Electrical Rating** — (each switch)
5 amperes 125/250 volts a-c;
2 1/2 amperes 30 volts d-c inductive;
4 amperes 30 volts d-c resistive.

**TYPICAL UNIMAX
SUBMINIATURE SWITCH TYPES:**

USM



USMW



USMB-1



Unimax subminiature switches are available with other actuators.

For complete information on subminiature, and other Unimax snap acting switches, write today.

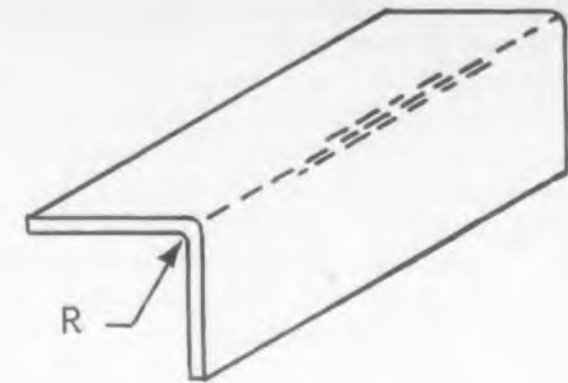
UNIMAX SWITCH

Division The W. L. Maxson Corporation
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 58 ON READER-SERVICE CARD

Table 2B. Minimum Bend Radii for 4130 Steel

Thickness (in.)	Bend Radii (in.)	
	Annealed	Normalized
.025	1/32	1/32
.036	1/16	1/16
.050	3/64	3/32
.063	7/64	5/32
.080	1/8	5/32
.100	9/64	3/16
.125	3/16	1/4
.160	15/64	5/16
.181	7/32	1/2
.250	19/32	5/8



Cracks appear here when bend radius is so small that there is rupture on the extreme fibre. R (min) depends on material and degree of hardness of the material used.

Table 2C. Bend Radii (min.) for Non Structural Electronic Parts (in inches)

Thickness (in.)	Alloy			
	52SO, 61SO, 2S	2S-H12 & H14	52S-H32 & H34	61S-T4
.032	3/64	3/64	3/64	3/64
.040	3/64	3/64	3/64	3/64
.051	3/64	3/64	3/64	1/16
.064	3/64	3/64	3/64	5/64
.072	3/64	3/64	5/64	7/64
.081	3/64	3/64	5/64	7/64
.091	1/16	5/64	7/64	7/64
.102	1/16	5/64	7/64	7/64
.125	1/16	3/64	9/64	9/64

- Minimum distance between flows of staggered welds
 - Minimum overlap, flange width or "flat" required
 - Minimum unobstructed area required to place a weld (diameter)
- For Steel—**
- Flange width should be in accordance with the table.

Tolerances

Tolerance of $\pm 1/64$ in. is adequate for economical production of sheet metal chassis where the material thickness does not exceed 0.075 in. This includes tolerance from hole centers to bend lines and overall tolerance including two bend lines. The overall tolerance (length, width and height) whenever possible should be $\pm 1/32$ in. in order to expedite and prevent unnecessary rejections by incoming inspection.

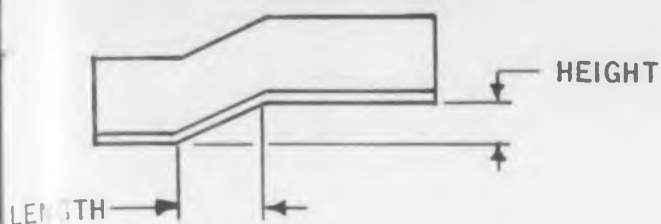
Tolerances on small quantity items such as transformer mounting bracket, etc. where the material thickness exceeds 0.075 in. should be more liberal— $\pm 1/32$ in. or $\pm 1/16$ in. since it is unlikely that a setup would be made on items of this type.

It should be noted also that the more bends a chassis has, the more chance for deviation because even with a setup the thickness of mill sheets may vary and parlay into each succeeding bend. A cost reducing remedy for limited quantity production would be to dimension the first hole with a tolerance of $\pm 1/32$ in. and use that as a base line for other related holes with tolerance requirements of $\pm 1/64$ in.

Material Thickness Selection

Careful consideration should be given to this item since the thicker the material the less die

Table 3. Offset Design Data



Height Of Offset (in.)	Length of Offset (in.)	
	20° For Steel & SO Al Alloy	10° For ST & SW Alum Alloy
.032	3/32	3/16
.040	1/8	7/32
.045	1/8	1/4
.051	3/32	9/32
.057	3/32	5/16
.064	3/16	3/8
.072	7/32	7/16
.080	7/32	15/32
.090	1/4	17/32
.102	9/32	19/32
.114	5/16	21/32
.125	11/32	3/4
.144	13/32	27/32
.162	7/16	15/16
.187	17/32	1 1/16
.250	1 1/16	1 3/8
.312	7/8	1 3/4
.375	1 1/8	2 1/8

life and greater tolerances required when bending and forming operations are required. It has been determined that 0.046 in. material thickness is sufficient when a piece does not exceed approximately 3 sq. ft.

Bend Radii and Flange Widths

The minimum permissible radii shown in Table II are subject to several variables and can only reliably be determined by actual forming under specific manufacturing conditions. Alclad 2024-T3 (24S) and Alclad 7075 (75S) permit slightly smaller radii than bare.

Where the flange widths of chassis and parts are not in accordance with the recommended practices, a good clean bending operation is not possible and press marks are prevalent. Excessive amounts of time are spent removing these marks resulting in added cost.

If it's worth
engineers'
time...



...it's worth
engineered
electronic wire



Magnet Wire • Lead and Fixture Wire • Power Supply Cords, Cord Sets and Portable Cord • Aircraft Wires
Welding Cable • Electrical Household Cords • Electronic Wires • Automotive Wire and Cable

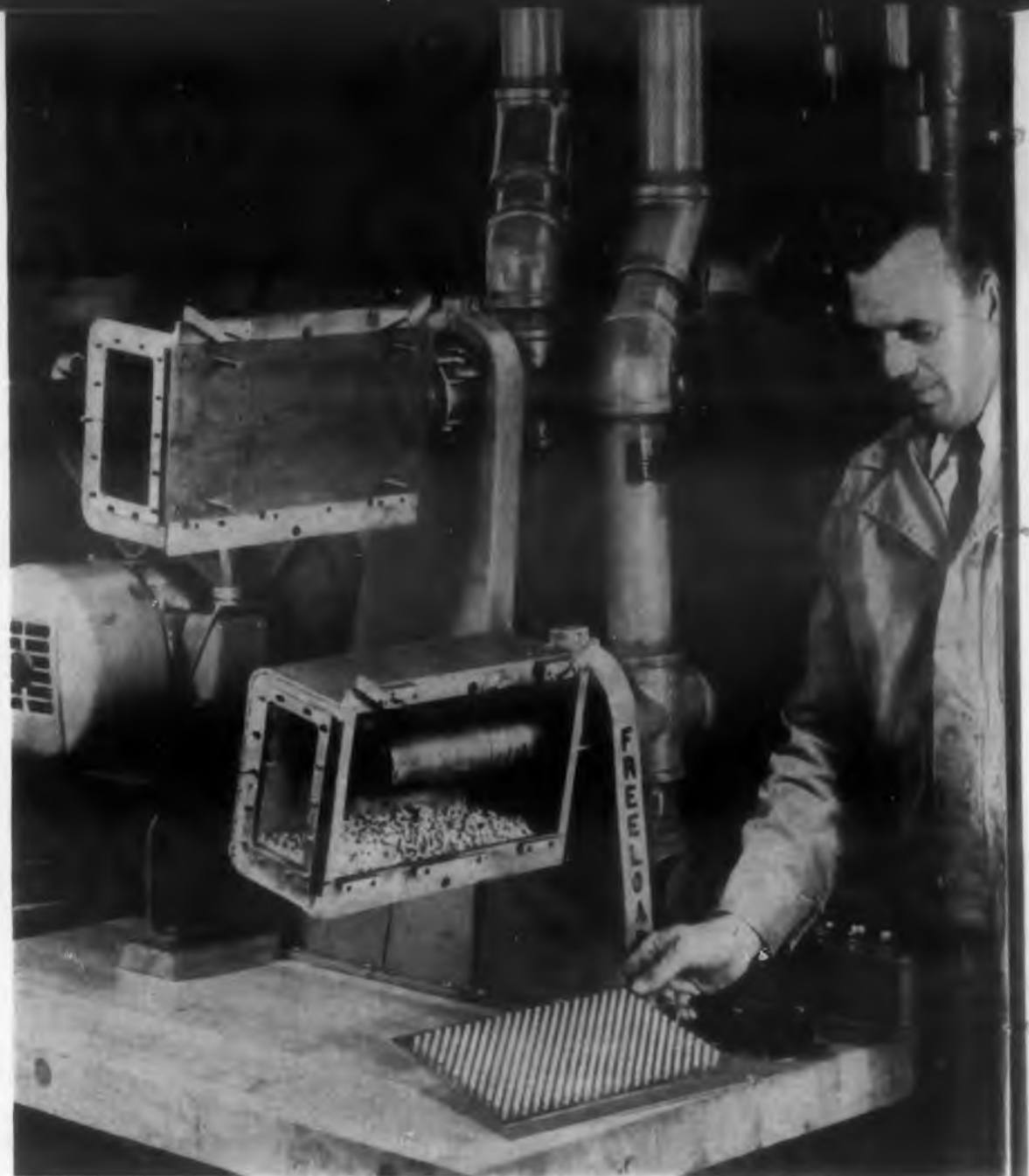
CIRCLE 59 ON READER-SERVICE CARD



Design for
LOW-COST PRODUCTION

Blow-Loader— Key to Small Parts Handling

Fig. 1. This blow-loading machine, called the "Freeloader," speeds production for the small parts user by automatically loading as shown.



IT HAS been recognized by engineers that the molding of metal inserts directly into the molded part is a superior method of assembly. However, the cost of this method previously has been much higher than assembly-after-molding methods because of the slowness of the insert loading operation. Now this and other problems are solved by a semi-automatic parts loading machines called the "Freeloader," made by Whitso, Inc., Schiller Park, Ill. It is particularly useful in handling miniaturized parts.

What It Is

The Freeloader consists of a rectangular drum into which air is blown. When in use, this drum oscillates through a 240 degree arc, and air is supplied by a centrifugal blower. The parts to be loaded are put in the drum in bulk, and a collector plate is clamped to one face of the drum. This collector plate has holes of suitable shape and on the desired centers. As the drum oscillates, the mass of parts slides over the holes, the ends of the parts seek the holes, and the flow of air carries the parts into the holes and holds

them in place. When the collector plate is filled, the drum is parked, and the collector plate is removed. The parts are now arranged and oriented as desired for subsequent batch operations. The collector plate is vital to the blow-loading technique and must be engineered for each loading application.

Parts Design

It is essential, of course, that the parts will be accepted on one end by the holes in the collector plate and rejected on the other. Given this condition, rapid loading is the objective, and the proper use of chamfers, shoulders, and barriers in and around the collector plate holes will bring loading time down to a minimum. The collector plate can be used as a work holder for subsequent assembly operations, or the parts can be transferred to another fixture.

In the case of plastic molding the parts are transferred to a loading fixture and from there into the mold. The Freeloader was first employed in a molding operation producing standoff terminals for electronic applications. As part of his

molding cycle the operator had been loading a 20 cavity mold with two inserts per cavity, using tweezers because of the small size of the parts. When the Freeloader was used to replace the manual loading, the operator could do in one hour what previously required more than half of his working day.

Loading operations worked on to date have required from 30 seconds to 3 minutes to fill the collector plate. While this may sound like a relatively long time, the number of parts loaded is high, and the hourly volume of parts is generally much greater than in "one-at-a-time" techniques. If necessary, production can be increased by the use of two-drum models, multiple patterns in the collector plates, and duplicate plates.

Applications

Two typical applications of the Freeloader are in plastic molding and in assembling of terminal boards. It can also be used in simple assembly operations. One example is in the manufacture of hermetically sealed terminals where two metal parts and one glass part are assembled and

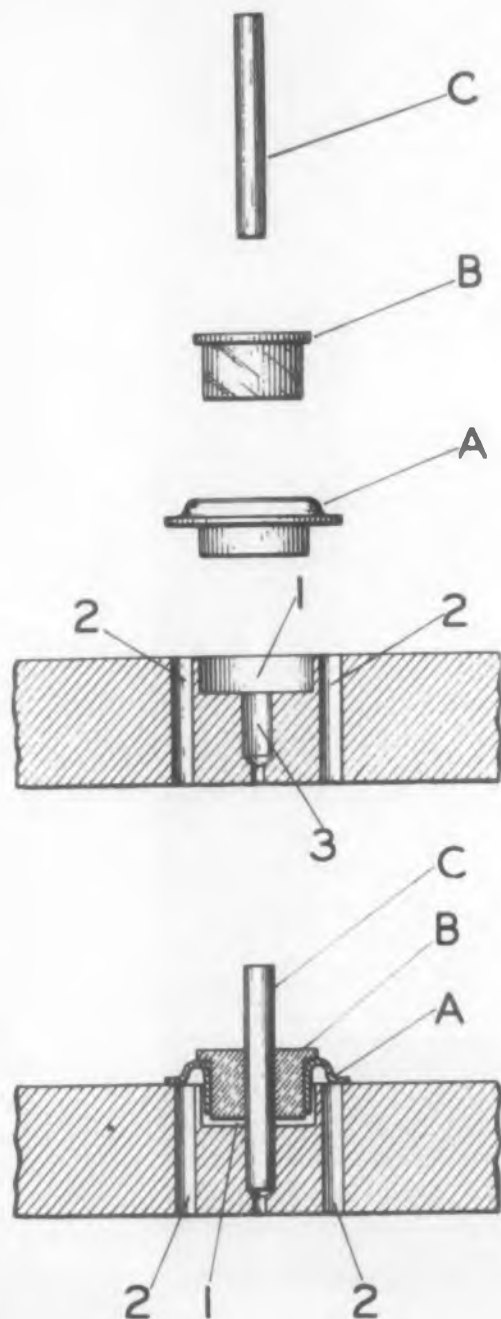


Fig. 2. Typical electronic and electrical "hardware" handled by the Freeloader. Items were manufactured by various methods—screw machine, stamping, molding and forming. Brass, steel, glass and plastic parts such as these are often small enough to require the use of tweezers with conventional assembly or processing methods.

placed in a carbon block for subsequent fusing operation. In this application 118 pieces of each of the three parts are collected in separate collector plates. The parts from each plate are then assembled, a batch at a time, into the carbon block all by means of the proper fixtures. Production per operator was increased five fold over previous methods.

The Freeloader requires 220 v for operation, although 110 v may be furnished, if required. It occupies 12 sq ft of floor space, and is available in three models—single drum, double drum with individual drive. For additional information circle 425 on Reader-Service Card.

Fig. 3. In manufacture of hermetically sealed electronic terminals, Freeloader speeds assembly operation involving three small dissimilar parts. A, B, and C are loaded in individual collector plates holding 118 individual pieces each. Using transfer fixtures, operator then inserts parts batch-at-a-time into carbon block for fusing process. (A—stamped metal ring, B—glass bead, C—feed-through conductor. 1—counterbore in carbon block to permit seating of A and B; 2—ports or holes for evacuation of underside of A; 3—counterbore to receive and position C).



HHB 'DT' SERIES



CONNECTORS

38 ARRANGEMENTS
TOOLED FOR FAST PRODUCTION
— Quick Delivery

Now . . . HHB can supply their 'DT' Series Connectors in practically any contact arrangement.

Features: die-cast aluminum split-shell type for mounting and alignment. Melamine inserts. Gold- or silver-plated beryllium female contacts, phosphor bronze male contacts in sizes 20, 16, 12 and miniature coaxial.

Write—tell us your connector needs.

CONNECTORS — AN types · RF types
 · Rack & Panel · Printed Circuit
 CABLE ASSEMBLIES & COMPONENTS

H. H. BUGGIE, Inc.
 Box 817, Toledo 1, Ohio

Skilled in Electronic Component Parts
RESEARCH · DESIGN
ENGINEERING
MANUFACTURING

Sales Engineers in All Principal Cities

CIRCLE 60 ON READER-SERVICE CARD

REDUCE WEIGHT

SAVE SPACE

IMPROVE PERFORMANCE

in Airborne Communication
and Navigation Equipment



HYCON EASTERN, INC.

75 CAMBRIDGE PARKWAY

CAMBRIDGE 42, MASSACHUSETTS

To Designers of Aircraft and Missiles:

The July 24th issue of "The New York Times" described a new radio and radar component no larger than a cigarette lighter that simplifies the design of complicated electronic equipment. Known as the high frequency crystal filter, it is unaffected by abrupt temperature changes and repeated heavy shock and vibrations.

These units permit excellent reception in the presence of strong jamming or interfering signals. Maintenance is reduced to almost zero and alignment in the field is eliminated. Center frequencies are accurate to .001%. Insertion loss is 1/10 of other filtering methods. Aircraft and guided missile environmental requirements are exceeded.

Our Company has pioneered in the development of crystal filters. A number of standard models are currently in mass production. Many manufacturers of radio and radar equipment have developed improved systems utilizing Hycon Crystal Filters. It will pay you to ask your sub-contractors how this unique component can make your missiles or aircraft a more effective weapons system. If they are not familiar with the advantages of crystal filters, we can help you. A request on your company letterhead will receive a prompt reply.

Cordially,

Malcolm M. Hubbard

Malcolm M. Hubbard
President



Design for
LOW-COST PRODUCTION

Vacuum Me

A VACUUM metallizing equipment is now available to companies that need a moderately priced, medium capacity vacuum coater which approaches the efficiency of large production units. Its applications include metallized capacitors, TV tubes, piezo-electric crystals, transistorized printed circuitry, and "window" making.

How It Works

The NRC Model 3143 comprises a 5 foot long, 42 in. horizontal coating chamber which provides 12,000 sq. in. of coating capacity per load. Two filament rods and a planetary jig which accommodates four work holding rods are cantilevered from the one head of the chamber which remains stationary. This arrangement eliminates flexible power and water connections and provides maximum accessibility for changing the evaporating filaments and loading and unloading the work. The inside of the chamber is readily cleaned by removal of "Narliner" strippable plastic film which takes with it deposits of coating metal which accumulate after several cycles.

A pumping system, consisting of a rotary gas ballast mechanical pump and a 16-inch high vacuum oil diffusion pump with necessary piping and valves is connected via a short, efficient manifold to the coating chamber.

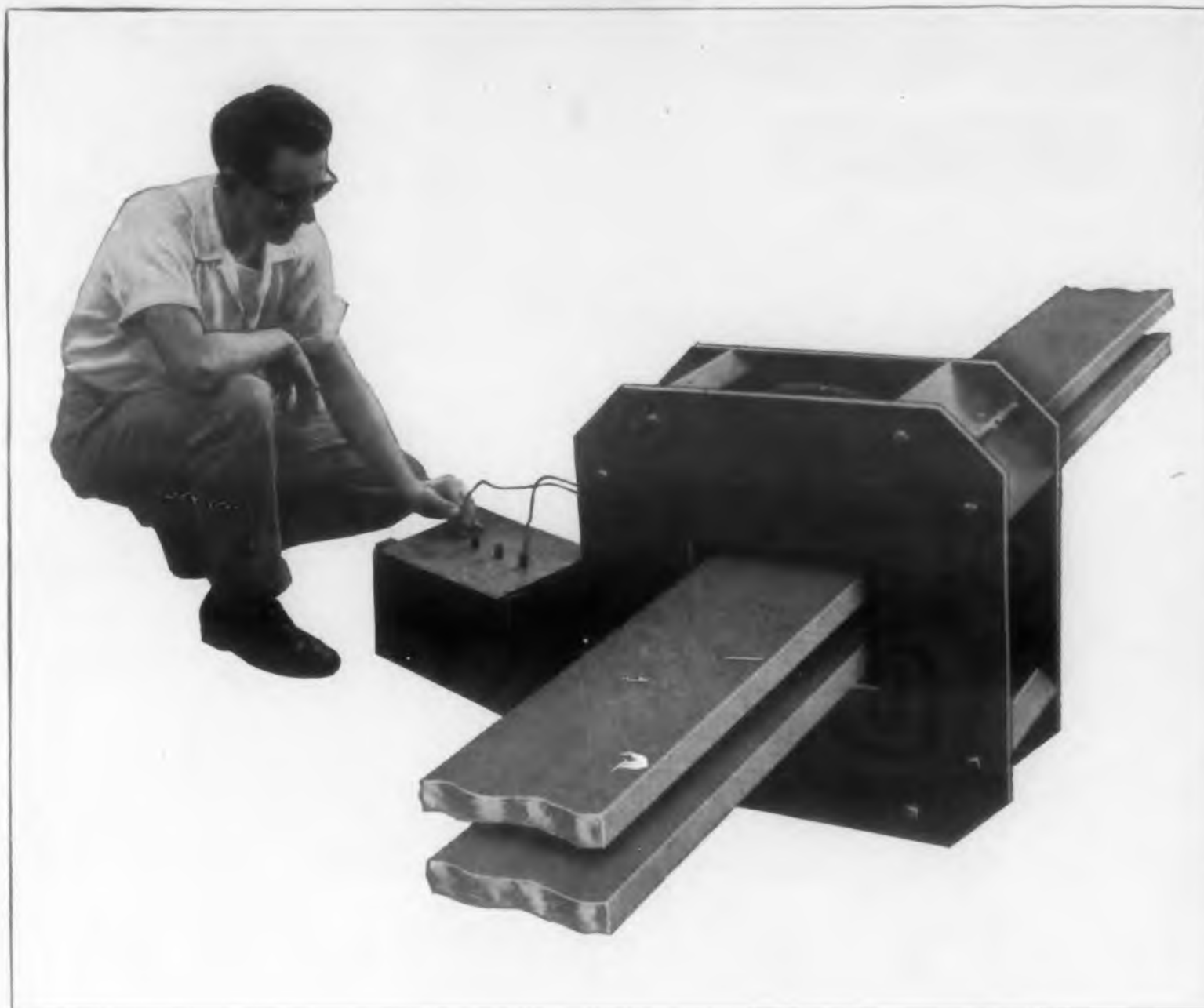
Operation is from a panel with electrical and pressure measuring and control devices centralized. Pressure is indicated by a combination of ionization and thermocouple gages which measure vacuum condition at all important points in the system. A variable speed control for the motor driven planetary jig is also panel mounted.

For more information on this equipment contact the NRC Equipment Corp., Newton Highlands, Mass. or turn to Reader-Service Card and circle 426.

m Metallizing Unit



Batch type metallizing unit, used in the production of metallic films on both metallic and non-metallic substrates. The vacuum chamber is exhausted by means of a high vacuum pumping system shown. Small loops of wire of the metal being coated, usually aluminum, are hung over tungsten filaments. Products to be coated are loaded in a rotating jig on rods. When the "door" is closed, the chamber is pumped down to a pressure of less than 1 micron of mercury absolute. The filaments are heated electrically, causing the metal to boil and project individual molecules of vapor through the evacuated space to condense on the surface of the work.



Now . . . measure 200 to 10,000 amperes with isolated meters—CONTROL's Standard Transducers

CONTROL transducers have made obsolete the use of shunts for metering or recording heavy d-c loads. Now, for the first time, a standard line of transducers—nine units ranging from the 200-amp to the 10,000-amp size—make it possible for the systems engineer to measure high bus currents without direct electrical connections into the circuit.

CONTROL transducers are saturable reactors, through which the bus or cable passes. Output is linearly proportional to the bus current, with an accuracy to $\pm 1\%$ of full scale reading. Supply voltage variations of $\pm 10\%$ will not affect this accuracy.

In addition to eliminating the need for breaking into the circuit for connections, the CONTROL transducer has another major advantage over the shunt-millivoltmeter. The transducer will deliver relatively large amounts of power to permit such things as overload relaying and to permit a feedback signal for a magnetic amplifier.

No longer need you be dependent upon "what's available" or a special design. Catalog T-10 gives you a standard range of transducer sizes to meet your every need. For full details . . . CONTROL, Dept. ED-43, Butler, Pa.

Reliability begins with **CONTROL**



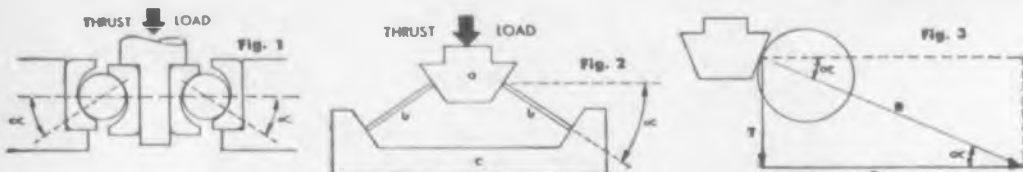
A DIVISION OF MAGNETICS, INC.

CIRCLE 62 ON READER-SERVICE CARD

MICRO-BEARING ABSTRACTS

by A. N. DANIELS, President
New Hampshire Ball Bearings, Inc.

CONTACT ANGLE



Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In Fig. 1, the contact angle is represented by angle α . The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In Fig. 2, a simplified version of Fig. 1, the shaft and inner ring combination are represented by the plug a , the "working diameters" of the balls and represented by the rodlike members at b , and the outer ring is represented by the tapered cup c .

The contact angle is α . This diagram represents a three-dimensional structure with as many equally spaced rods, b , as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod b is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in Fig. 3.

The sides T and R , are vector quantities, and diagonal B is the vector sum of T and R . Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B , the force actually felt by the raceways and balls, compared to vector T , the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE

CIRCLE 63 ON READER-SERVICE CARD



With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ lbs.}}{\sin 5^\circ} = 34.5 \text{ lbs.}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example 1, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play. In addition to the above considerations, gyratory forces become extremely important factors in determining optimum contact angle in high speed applications.

A more complete discussion of contact angle is found in our design handbook.

DESIGNERS HANDBOOK OFFERED FREE TO ENGINEERS

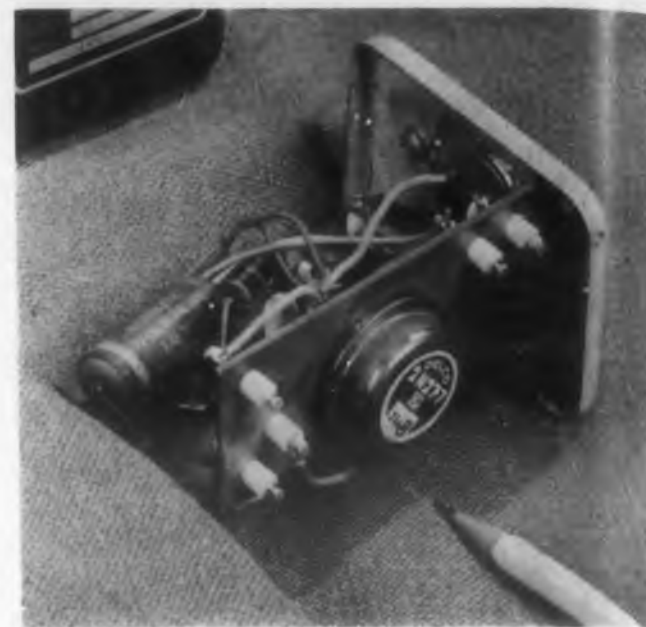
If you work with miniature bearings, you'll find this new, 70-page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents. Write to: New Hampshire Ball Bearings, Inc., Peterborough 1, N.H.



Design Forum

Reliable Vibrator Replacement



SWITCHING up to 9 a in a 12v system on positive or negative sources, this transistorized inverter can replace mechanical vibrators now being used in mobile radio equipment. The rather simple and economical circuitry embodied in this design makes one pause to wonder why this type of inverter was not made commercially available before. The absence of moving parts and use of transistors provide a considerable improvement in reliability and life over mechanical units. It is designed for conven-

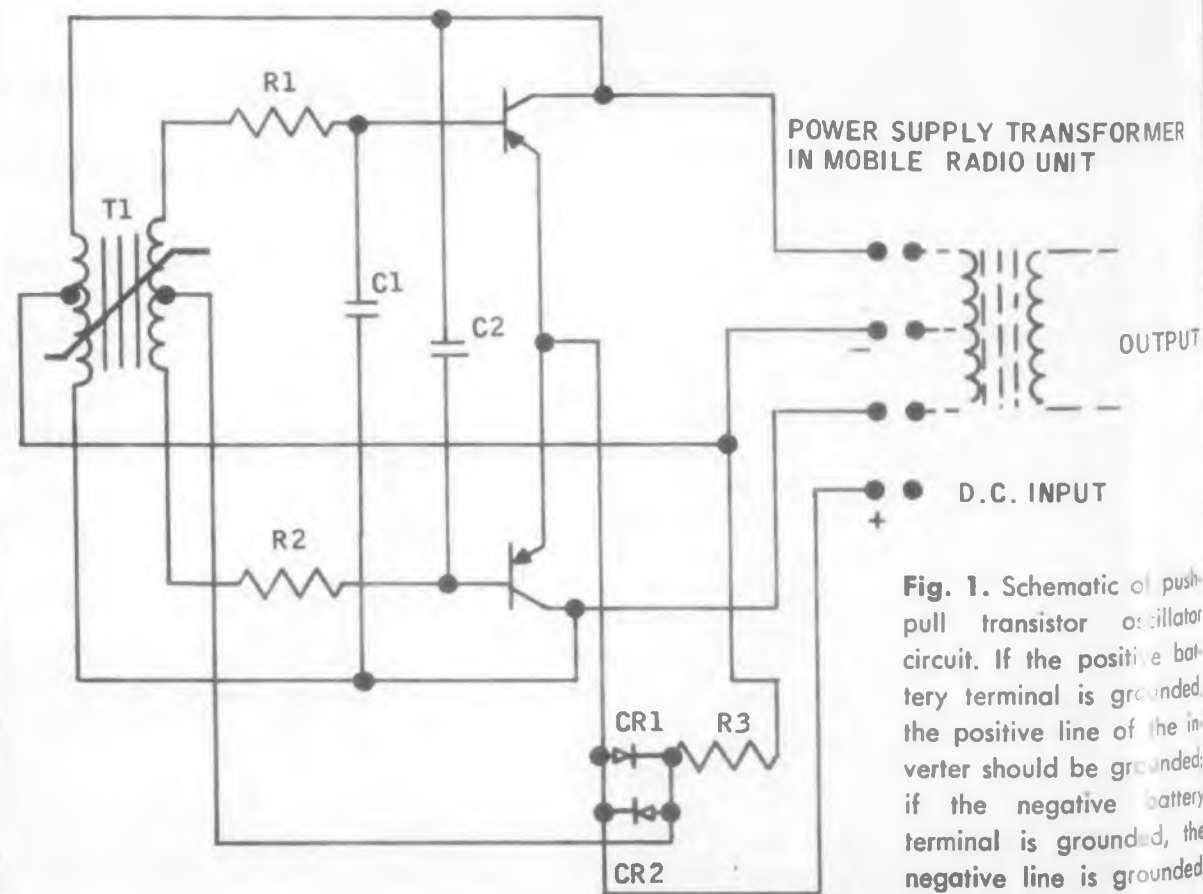


Fig. 1. Schematic of push-pull transistor oscillator circuit. If the positive battery terminal is grounded, the positive line of the inverter should be grounded; if the negative battery terminal is grounded, the negative line is grounded.

Transistorized inverter is used as a vibrator replacement for mobile communications systems. Output is 9 a at 12 v, 110 cy. Only modifications necessary are removal of buffer resistors, capacitors, and oil mechanical vibrator.

ient physical replacement as well as electrical, the removal of the old vibrator socket and buffer capacitors and resistors being the only chassis changes necessary.

Designed by Transval Engineering Corp., Culver City, Calif., the vibrator replacement changes low voltage dc to square wave ac. Switching rate is a standard 110 cps, and power consumption is somewhat less than for the usual mechanical vibrators.

The inverter uses the square loop saturation characteristics of the core materials to provide switching times in the order of several μ sec in a push-pull transistor oscillator circuit. Switching is aided by providing auxiliary feedback circuits as in Fig. 1. To provide rapid switching of 100w output, the switching reactor is separated from the power transformer. This is done by using a small toroidal saturating transformer to provide feedback for switching the 2N277 transistors. The chopped ac current is then fed to the power transformer of the mobile unit, making the inverter a true vibrator replacement.

Additional feedback for the switching interval is provided by capacitors C1 and C2 of Fig. 1. A substantial improvement in switching speed results from their use. Bias for the transistors is maintained at a value which provides reliable starting over the range -55 to $+140$ F by R3 and diode CR1. Diode CR2 reduces the bias bleeder current needed to produce switching action.

The vibrator replacement package measures 2-1/4 x 2-11/16 in. wide and is 3-3/4 in. high. Weight is 11 oz.

For further information concerning this transistorized vibrator replacement turn to the Readers' Service Card and circle 414.



For Alnico Magnets—Stock or Special

Specify "ARNOLD"

Materials

Cast Alnico Magnets are most commonly made in Alnico V, VI or III. Sintered Alnico Magnets usually are made in Alnico II, V or VI. Special permanent magnet materials include Vicalloy, Cunico, and Cunife.

Engineering Data

**Write for your copy
BULLETIN GC-106 C**

Contains useful data on Alnico Magnets, their physical and magnetic properties. Also lists stock items and standard tolerances for cast and sintered magnets.

ADDRESS DEPT. ED-711

Your best bet when looking for a source of Alnico magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry. Arnold can supply your need for any size or shape of Alnico magnet, as illustrated by the variety pictured above. Weights range from a few ounces to 75 pounds or more. Die-cast or sand-cast aluminum jackets, Celastic covers, etc., can be supplied as required. Complete assemblies are available with Permendur, steel or aluminum

bases, inserts and keepers as specified—magnetized and stabilized according to the requirements of the application.

A wide range of the more popular shapes and sizes of cast and sintered magnets are carried in stock at Arnold. Unsurpassed plant facilities make possible quick delivery of all special orders. • *Let us handle your magnetron, traveling wave tube and wave guide permanent magnet requirements, or any other magnetic material specification you may have.*

www 0078

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois
 Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:
 Boston: 200 Berkeley St. Los Angeles: 3450 Wilshire Blvd.
 New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.

CIRCLE 64 ON READER-SERVICE CARD



Design for
LOW-COST PRODUCTION



Typical "stock" cabinet. Aluminum is standard at Zero. Secondary operations can bring out distinctive features as required at low cost. Cost of tooling on such recessed and contoured cabinets as this ($7\frac{3}{4} \times 11 \times 99$) is approximately \$2000 when initially designed. But, when such "stock" cabinets are available, no tooling costs are entailed.



Removable front of cabinet is formed on same basic tooling as case, refined by secondary operations.



First Step in manufacture of cabinet is drawing of aluminum box. This is the way it comes from draw die. Note radii and wrinkle-free corners.

Standard "Cans" Cut Enclosure Costs

BY MANUFACTURING skill and accumulation of hundreds of "standard" dies, the Zero Manufacturing Co. in Burbank, Calif., is able to furnish at low cost, deep-drawn metal cans in small quantities as enclosures for most any piece of electronic equipment. Some of the typical shapes available are shown here. Deep-drawn aluminum is their specialty. Tooling is required to do deep drawing, but by utilizing tools already on hand, the designer is not charged for tooling—only a piece cost. And delivery is quick. By stocking hundreds of "standard" cans, shipment can often be made the day an order is received. Trimming of "stock" cans is the only operation generally required to tailor the can to a customer's requirements.

Zero's "secret" of success need be no secret to the electronic designer. Engineers can profit by their forward-looking approach to design. The "secret" is basically standardization coupled with a knowledge of what can actually be accomplished with the deep-drawing process. Some odd fallacies have been debunked, too.

We asked T. C. Coombs, Zero's chief engineer, some questions on their process. Here are his forthright answers, which should help designers know when to consider deep drawn enclosures.



Versatility of deep-draw process is shown in the wide range of sizes, shapes and styles of enclosures, chassis, boxes, cans, and cabinets that have been produced.



Basic Tooling for the cabinet shown on opposite page consists of a pressure plate, draw ring, and punch. Secondary tooling consists of a steel-sheathed masonite male and female pair for recessing the cover, which is drawn initially on the same die as the box.

are of mild steel rather than tool steel, making dies easier to fabricate. Where a hard surface is necessary for long-run fabrication chrome plating is given to the dies. No annealing is generally required or desirable on aluminum.

What kind of press is used?

Single-acting, hydraulic press. The material is forced down over the male punch.

What is the life of a die?

With chrome plating of the die, die life is unlimited because it can be replated as required.

Is it true in draw work that it is necessary to heat treat?

Not necessarily. By cold flow of the material, work hardening occurs. This hardening occurs mostly in the outer surface; the middle core remains somewhat soft, and this will absorb sharp blows without cracking or fracture.

What happens in heat treating?

If heat treated to increase tensile strength, relative hardness of surface to core is maintained.

What quantities are required for economical production?

About 350 to 500 is the break-even point.

How much draft is required?

It is possible to hold squareness of sides to ± 0.010 in. or better on smaller sized parts.

How expensive is the tooling?

Draw tooling can be amortized in the first 300 to 500 parts at a total cost not to exceed fabrication in the usual manner. In future quantities, no tooling costs result.

What tolerances can be held on trimming?

To 0.005 in. in cases under 16 in. diam; over this diam 0.01 in.

What details can be had as modifications to standard rectangular cans at low-cost?

Ribbing, beading, dimples, recess areas, etc. Such modifications can generally be made using inexpensive masonite dies and at low cost.

Do you need large radii?

No, one can draw to a radii as little as 4 x metal thickness.

When should you check with a deep drawing concern what can be done?

Any time there is doubt. At Zero, for instance, advice on engineering matters is freely supplied.

Why deep draw?

Uniformity of parts; suitability for limited runs; smooth appearance; elimination of welding, dressing and other hand operations.

What is the advantage of a deep drawn part over a casting?

Wrought material vs porous material. Lighter because of lighter wall. Finishing is simpler; almost ready for paint when drawn. Attachment of parts is easier even though bosses can be cast in place. Inspection of welds are costly. More reliability.

What materials can be worked?

Aluminum (SO alloys), brass, copper, and steel. Mild steel dies are generally used for aluminum or magnesium only. Plastic-metal laminate and alcuplate (copper on aluminum) can also be drawn.

What material is best for the process?

Aluminum is best. It is light and strong. Material cost is small compared to total cost of fabrication, so material cost difference is of no basic concern.

What gage of aluminum can be drawn?

Any standard gage. 0.064 in. is usually selected.

What can't be done?

Can't draw radius less than about 4 x material thickness.

What finishes are available?

Most any, such as anodize copper plate, fabricate in alcuplate, crackle.

What is the maximum can size that can be drawn in one piece?

Depends on equipment. 22 x 33 x 10 in. deep has been drawn. There is no basic limit on size provided a suitable press is available.

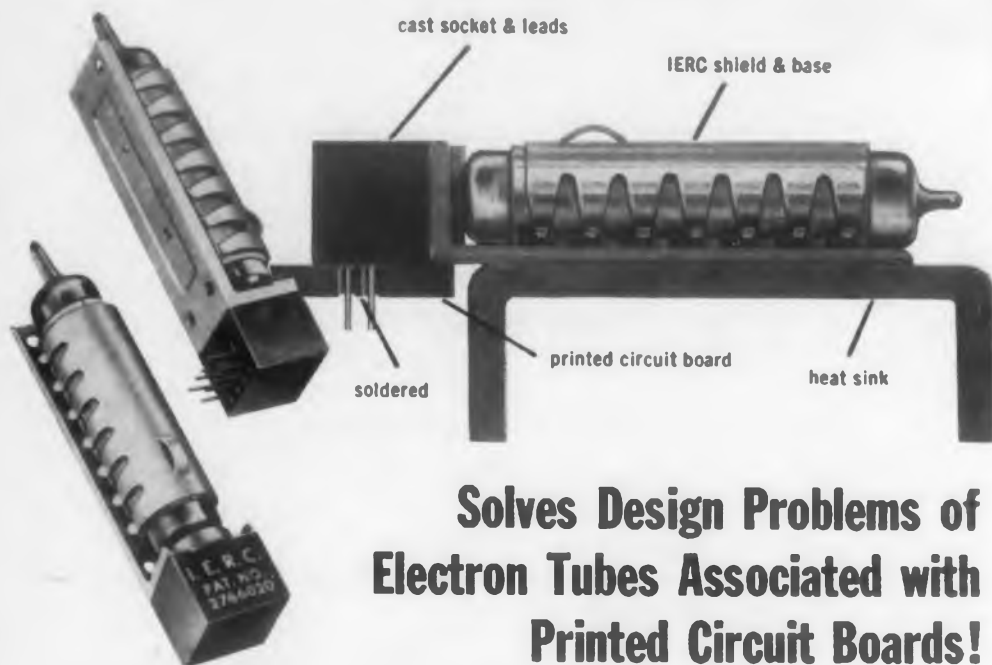
What by-products accrue from deep drawing?

Appearance can be obtained at low cost or at no additional cost.

What is the Zero method of deep drawing for short run production?

Tooling is simple, consisting only of a draw die, pressure ring, and a punch. A simple method has been developed for making the dies. The dies

IERC Heat-dissipating "plug-in" Tube Shields for Printed Circuits!



Solves Design Problems of Electron Tubes Associated with Printed Circuit Boards!

IERC's latest heat-dissipating tube shields for round button and flat press subminiature electron tubes solve design and performance problems of tubes associated with printed circuit boards. Standard socket and an Epoxy resin are integrally cast to the shield base. Socket leads extend from the Epoxy casting 90° to plane of base permitting direct plug-in to printed circuits for hand or dip-soldering of connections. Bulb temperatures are maintained to within 5°C of the heat sink temperature per watt of heat-dissipation when shields are attached, as suggested, to a heat sink of proper thickness for conduction or hollow duct types permitting air or liquid circulation. IERC's patented design provides maximum cooling, excellent tube retention, shock and vibration protection under severe conditions. Pertinent dimensions are to .1 inch grid layout.

Patented and Patents Pending



Heat-dissipating electron tube shields for miniature, subminiature octal and power tubes

CIRCLE 65 ON READER-SERVICE CARD

International
electronic research corporation
145 West Magnolia Boulevard, Burbank, California

IERC Research and Engineering experience on improving electron tube life and reliability has won industry-wide acceptance and established IERC as *the Authority* for the best answers to your tube failure problems. Write today for free information on IERC tube shields—the *only complete line available* for new equipment and retrofitting programs.

Design Forum

Amplifier in a Thermos



Fig. 1. Thermos bottle housing for transistor pairs. Transistors are mounted on an aluminum heat sink, potted with paraffin inside the thermos bottle. Temperature difference between transistors is negligible; total temperature rise due to enclosure is 5 F.



Fig. 2. Power supply construction. Supply is independent of line frequencies between 50 and 400 cy.

JUDICIOUS use of a thermos bottle as a heat sink keeps germanium transistor pairs at the same temperature in this dc amplifier. Since a temperature change of a few tenths of a degree is sufficient to cause a shift of several hundred μ v a germanium transistor's dc operating point, the normal variation in temperature from one side of the cabinet to the other is not tolerable.

In order to maintain uniform heat distribution, the transistors are mounted in an aluminum heat sink. The entire assembly is then mounted in a thermos bottle for insulation from the outside environment. Paraffin is used to pot the transistors and heat sink in the bottle: the size of the heat sink is effectively increased. If replacement of a transistor is necessary, the paraffin can be melted and the heat sink assembly removed.

The rise in temperature due to transistor-produced heat is 5 F above ambient. At this temperature difference the rate of heat generation in the bottle is equal to the rate of heat loss out of the bottle. Total temperature buildup is kept in this way to 5 F above ambient; transistor life and

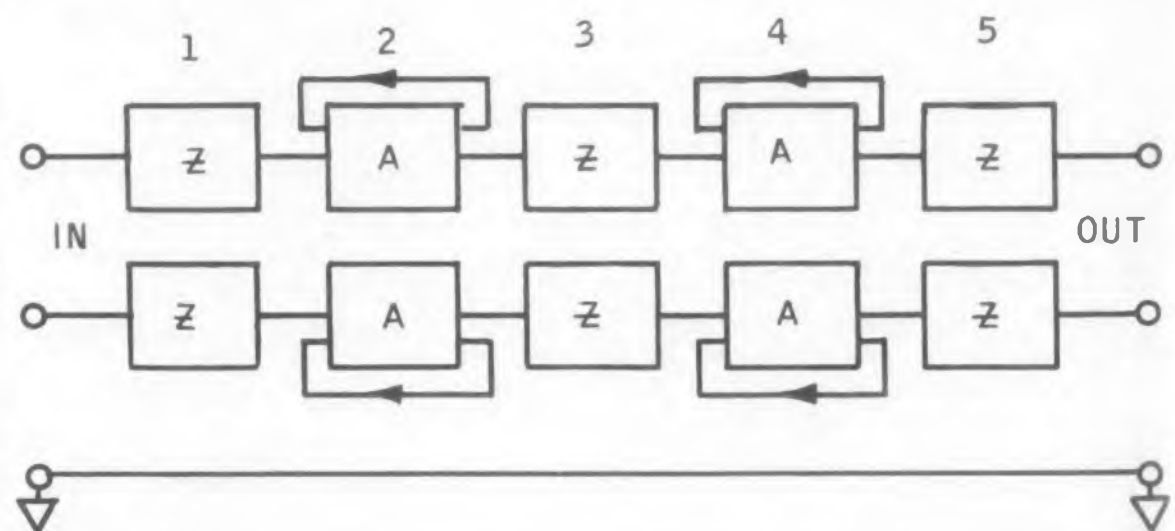


Fig. 3. Block diagram of Model 71 system. Stage 1 provides 0.5 meg input impedance, stage 2 is a linear amplifier with a gain of 25, stage 3 matches low input impedance of stage 4, a linear amplifier with a gain of 20, and stage 5 provides low output impedance for the device. Linearity of the amplifier is 0.2 per cent.

Thermos Bottle

performance are not impaired. Fig. 1 shows the thermos bottle assembly.

Developed by Video Instrument Co., Inc., Palo Alto, Calif., the Video 71 solid state differential dc amplifier maintains 3 μ v stability. Differential drift is minimized by the use of the thermos bottle heat sink, and common mode drift of the entire amplifier is held down by a transistor compensating unit.

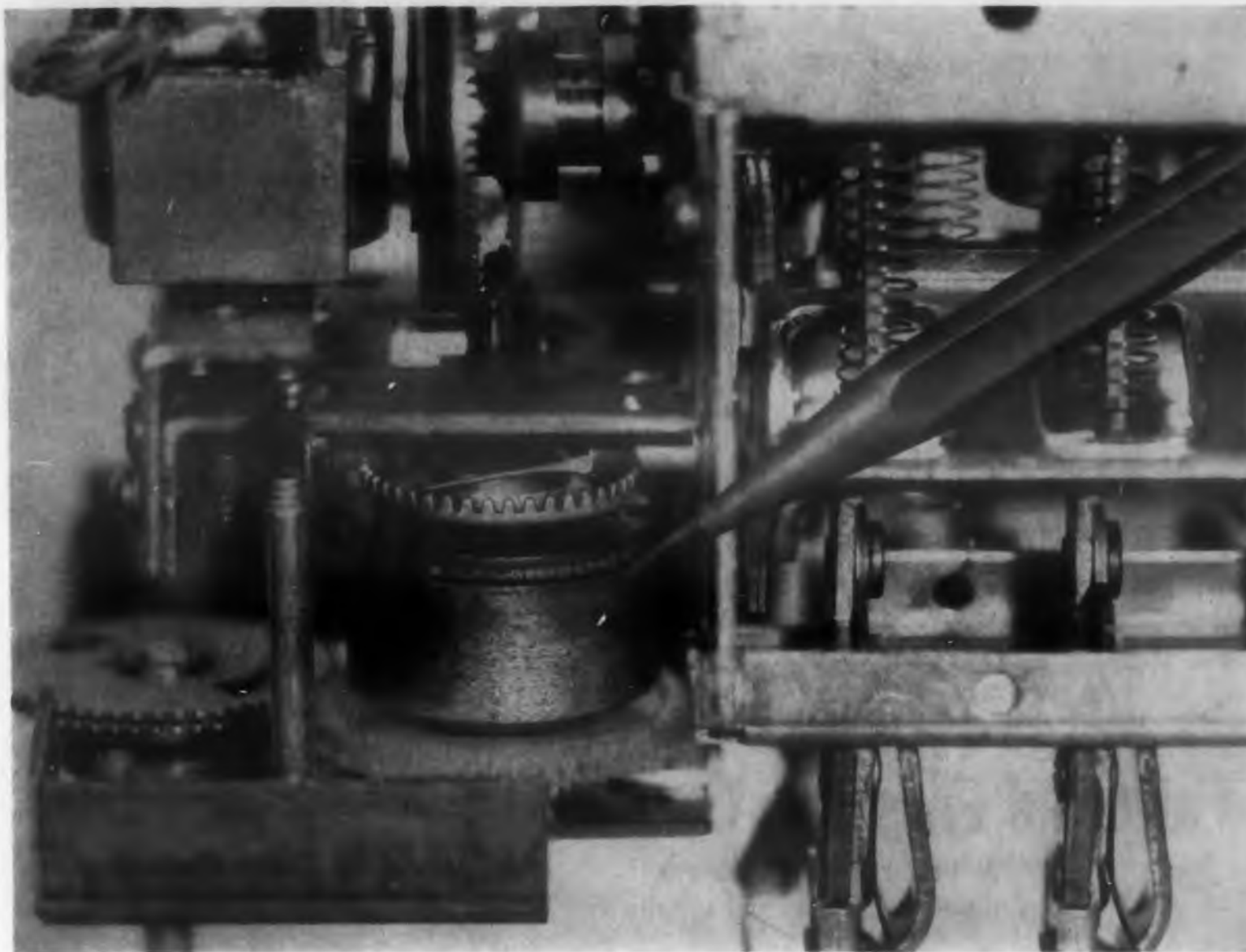
A 'true' dc amplifier, the Model 71 amplifies dc signals without an intermediate conversion to ac. The absence of chopping or modulation results in a 20 μ sec recovery time from overload, since there are no ac coupling capacitors. In instrumentation systems where a sampling switch precedes the amplifier, an overload on one channel may block subsequent channels if the amplifier recovery time is significant.

A block diagram of the Model 71 system is shown in Fig. 3. The two amplification stages employ feedback at each stage for stability and linearity. Gain without feedback would be 40,000; with feedback, gains of 25 and 20 respectively are obtained. Individual transistors are paired by matching measured beta, I_{co} and V_{be} . Use of a simple differential circuit results in virtual cancellation of zero shift effects due to changes of these parameters with temperature.

Differential signals can be converted to single-ended signals with this amplifier. Other modes of operation include differential input to differential output or single-ended input to single-ended output.

The amplifier has a bandwidth of dc to 50 kc; noise level from all sources over the full bandwidth is 3 μ v rms, referred to the input. The power supply is independent of 105 to 125v unregulated line frequencies from 50 to 400 cycles. Fig. 2 shows the power supply layout. Power consumption of the unit is 0.5va.

For further information on this differential dc amplifier turn to the Reader's Service Card and circle 415.



New low cost magnetic clutches from

Now you can get the same magnetic clutches used in today's finest signal seeking radio tuners. Originally designed by R/C for the rigid price-performance requirements of the automotive industry, they are finding new applications throughout electrical manufacturing. Designers are using them to replace cumbersome, complex assemblies . . . to save space and eliminate costly production steps. They show further promise in accomplishing jobs now being wastefully done with heavy duty and servo types at fifty to one hundred times the cost.

Two types of R/C magnetic clutch are in high volume production now. Designed for operation at from 11 to 16.2VDC, they are also available for 32V operation . . . and can be further modified to meet your special requirements.

We'll be happy to send you complete information on the two types shown, or if you wish, we'll have an R/C engineer at your desk ready to work with you to better fit R/C clutches to your needs.



Operating Characteristics Of New R/C Magnetic Clutches

Voltage	11 to 16.2V 32V also available
Torque	8 in.-oz. minimum
Residual Torque	0.3 in.-oz. maximum
Operating Temperature	130F to -20F
Relative Humidity	tested to 95%
Life	successfully completed 120,000 operations with no sign of failure

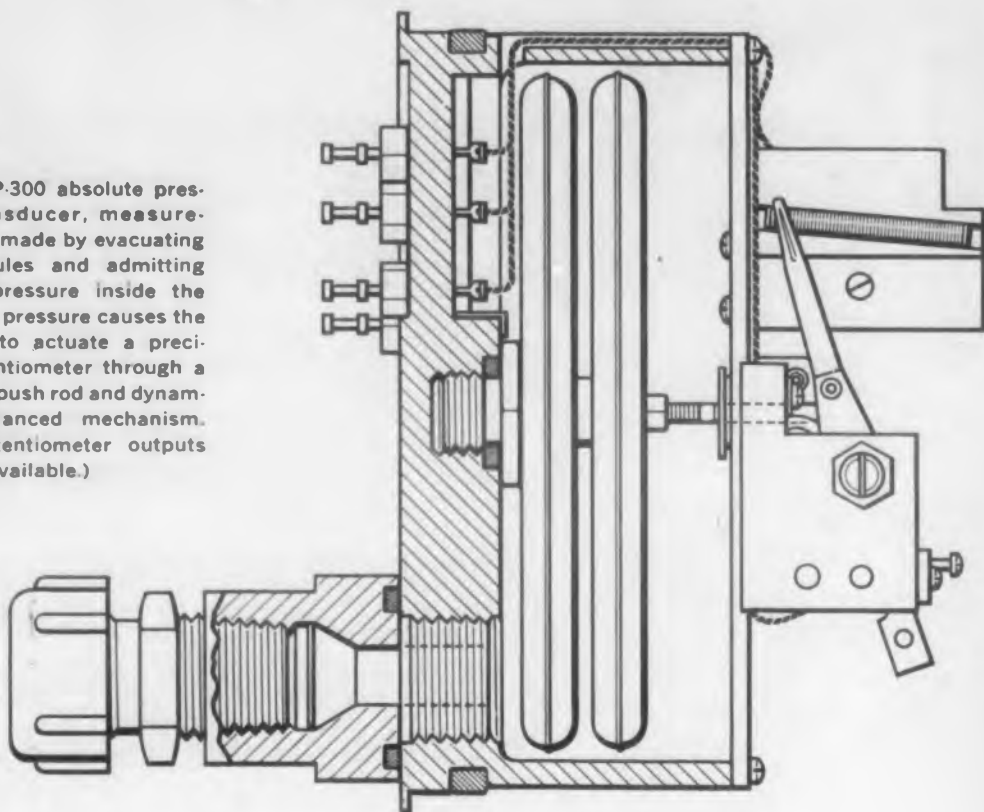


RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y.
CABLE: MINTHORNE
CANADA: Radio Condenser Co. Ltd. 6 Bermondsey Road, Toronto, Ontario

CIRCLE 66 ON READER-SERVICE CARD

In this TP-300 absolute pressure transducer, measurements are made by evacuating the capsules and admitting altitude pressure inside the case. This pressure causes the capsules to actuate a precision potentiometer through a low mass push rod and dynamically balanced mechanism. (Dual potentiometer outputs are also available.)



Fairchild Pressure Transducers

minimum size and weight
maximum ruggedness and sensitivity

A new line of precision pressure transducers embodies the same research, engineering and manufacturing skills that have made Fairchild the leader in the precision potentiometer field.

The various types include both diaphragm and bourdon tube actuated units for the measurement of pressures as low as 1 psi and as high as 10,000 psi. Fairchild precision potentiometer outputs are standard and available in linear and non-linear functions, with taps (welded, of course) as required. AC type pickoffs can also be supplied.

Attention to design details enables Fairchild transducers to meet the accurate and stringent specifications for missile and aircraft applications. For instance, in the TP-300 (cross section shown above) emphasis has been placed on ease and accuracy of calibration. Simple adjustments provide for setting linearity and end points to accuracies within 1%, as well as for setting sensitivity.

Miniature precision ball bearings are used in these rugged units. A dynamically counter-balanced mechanism minimizes acceleration errors and assures good vibration characteristics — to withstand vibrations as high as 25G to 2000 cycles.

Basic materials are rated for temperatures in excess of 200°C. Materials are carefully selected and combined to cancel out effects of thermal expansion. The result is a temperature-stable instrument with excellent constant calibration characteristics at extremes of temperature.

For data sheets or for assistance on specific problems write to Fairchild Controls Corporation, Components Division, Dept. 140-88N.


EAST COAST
225 Park Avenue
Hicksville, L. I., N. Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.

FAIRCHILD
PRECISION POTENTIOMETERS
and COMPONENTS

CIRCLE 67 ON READER-SERVICE CARD


SIX TRANSDUCCERS IN THE FAIRCHILD LINE




TP-300: 3" dia.; 0.5 to 0-100 psi; absolute, differential or gauge.




TPD-300: Dual Unit — two TP-300 units on a common base.




TP-200: 2" dia.; 0.5 to 0-100 psi; absolute, differential or gauge.



TPD-200: Dual Unit — two TP-200 units on a common base.



TP-201: similar to TP-200 except for case pressures as high as 4000 psi.



TPH-250: High Pressure Unit. A bourdon tube type available by the end of 1957, for measurement of pressures from 100 to 10,000 psi.



Design for
LOW-COST PRODUCTION

Ultrasonic Machining of Ferrite



Fig. 1. Getting ready to "machine" semiconductor wafers by ultrasonics.



Fig. 2. Ferrite toroid (magnified).



Fig. 3. Ferramic ring (right) produced by ultrasonic tool (left).

THE ULTRASONIC machining process removes hard and brittle materials by using high-frequency sound energy to agitate abrasive grains that chisel away the material to the shape determined by the ultrasonic tool.

Typical electronic components that can be machined ultrasonically include ferrite, glass, ceramics, germanium, silicon, and other conductors and semiconductors, and insulators.

In Fig. 1 the operator is shown positioning the ultrasonic cutting or dicing tool over rows of semiconductor wafers. The tool consists of 310 stainless steel tubes nested in an area approximately 1-3/4 x 1-3/4 in. It cuts over 11,000 rondels or discs per hour, each 0.076 in. in diameter x 0.023 in. thick.

Ferrite, as used in the electronics industry, is extremely brittle and difficult to machine. It quickly loads diamond wheels causing breakage and high scrap loss. Ultrasonic machining has proved to be the best method to work this material economically and accurately.

Magnification of the ferrite toroid shown in Fig. 2 is 50 to 1. The 0.0015 in. wide slot was cut through the wall of the toroid by an ultrasonic machine tool. A 0.001 in. silver pick-up is inserted in the slot. Such assemblies are used in quantity in electronic "brains." The problem of machining hundreds of such slots in ferrite toroids at a time is now under study.

Another ferrite application is shown in Fig. 3. Here, the problem was to produce ferramic rings from the solid with the least amount of stock removal and at maximum cutting rates. An ultrasonic trepanning type tool provides maximum cutting speeds with minimum stock removal.

Because ultrasonic tools can be used in the softened state, they permit close tolerance machining of brittle materials.

"Before" and "after" pictures of a ferrite toroid that will be used as a saturable reactor core are shown in Fig. 4. A new method of holding the toroids makes possible the shaping of multiple pieces at a time.

Part Details

- Ultrasonic machining permits the use of materials by the designer previously rejected because they were thought to be unmachinable. It does not change in any way the surface appearance, physical properties, chemical, electrical, magnetic, or metallurgical character of material. It does not burn, discolor, nor check.
- In its own way, ultrasonic machining can duplicate the results of conventional machining in

such operations as hobbing, broaching, and coining. It can also be applied in the manner of a single-point tool for engraving and die sinking. The ultrasonic machine tool can be used as a surface grinder wherein the workpiece is oscillated beneath the profiled, vibrating tool.

- Materials can be machined to a depth of 2-1/2 in. or more, and the effective machining area ranges up to 3-1/2 in. in diameter.
- Tolerance can be held to within 0.0005 in. on production and to accuracies of 0.0002 in. on specials. Corner radii to maximum 0.001 in.
- Ultrasonic machining furnishes 8 to 10 micro-inch finish on hard brittle materials.

For additional information on ultrasonic machinery, write Carl J. Linxweiler, The Sheffield Corp., Dayton, O., or turn to the Reader Service Card and circle 424.

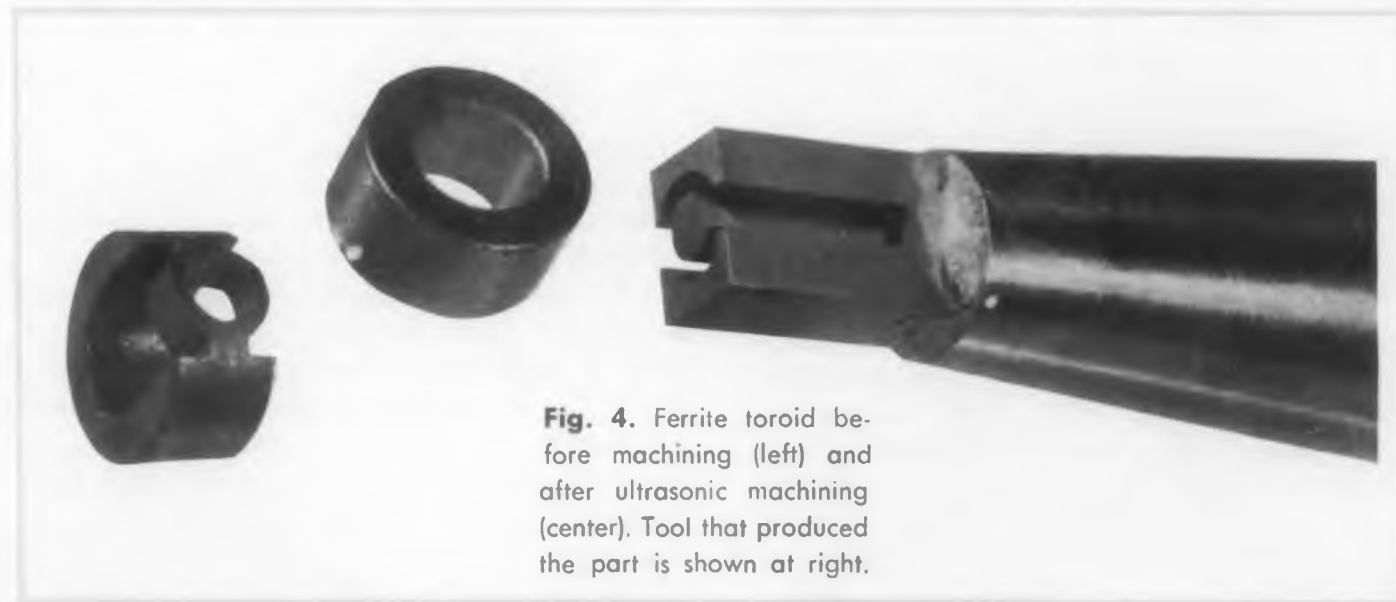


Fig. 4. Ferrite toroid before machining (left) and after ultrasonic machining (center). Tool that produced the part is shown at right.



Design for LOW-COST PRODUCTION

Presented here is the manner in which two companies have endeavored to cut the time needed to get a prototype design into full-scale production and at the lowest possible cost to manufacture.

Prototype Design Compatible with Production



Robert E. Gildroy
Chief, Quality Control
Chicago Aerial Industries, Inc.
Melrose Park, Ill.

MODERN design requires speed of action from the design concept to delivery of prototype and production equipment. Much thought has gone into this matter at Chicago Aerial Industries. Here is how it is done.

Initially, projects are derived from specific requirements for functional and environmental characteristics. Project parameters though, not only consist of technical requirements, but of budgetary and delivery limitations also. New equipment quite often is so urgently needed that a well organized facility capable of expeditious and ingenious methods of development, design, and production is definitely needed to cope with the difficult but firm delivery commitments.

Organization for Action

The engineering department is organized into project teams consisting of a project engineer and at least two designers. Each team specializes in categories of equipment, such as cameras, view-finders, electronic packages, etc. Each project team is assisted by support groups of research engineers, components engineers, systems engineers, environmental engineers, quality control engineers, manufacturing engineers, drafts-

men, model shop specialists, and prototype technicians. Upon receipt of a new assignment, the project team prepares a written "job scope" outlining all known technical facets and project ramifications including a tentative schedule.

During the design stages, a series of project meetings is conducted as follows:

- A Project "A" meeting at the inception of the job to acquaint all concerned personnel with the scope of the project.
- A Project "B" meeting upon completion of the preliminary design. The project engineer presents possible solutions to the problem. When the best method has been selected, the manpower requirement list and finalized schedule are then prepared.
- A Project "C" meeting upon completion of the final layout. At this time, the design is reviewed to assure that it meets the original requirements, applicable specifications, and the Company's specified standards.
- A Project "D" meeting when the job has been detailed and just prior to being submitted to the checking section.

The schedules normally include information

of the following nature:

- Starting date for preliminary investigation
- Starting date for electrical design
- Starting date for mechanical design
- Starting date for optical design
- Progress meeting
- Vibration test conformance investigation
- Shock, temperature, radio noise, explosion, etc. investigations
- Component selection dates
- Drawing checking dates
- Limited release dates
- Production release dates

Conditions outlined above have been selected as samples to illustrate some of the planned features provided in the schedule. An actual schedule will include dates and approximately 300 individual conditions or tasks that must be accomplished before a new design becomes a production product.

Selecting Components

While the project team is conceiving design requirements, the anticipated components are selected with the aid of the components engi-

needs. Production planners and buyers are consulted at this advanced stage to enable procurement of long lead-time components for delivery at the proper phases of engineering construction and production manufacturing. Considerable emphasis is placed upon this feature of the project due to the difficulties often encountered in attempting to obtain certain components on short notice from vendors.

Early Tooling

Tooling, including patterns for castings, also poses unique problems. Milling fixtures, drilling fixtures, etc., take considerable time to develop adequately. In a similar manner, wood patterns for magnesium and aluminum castings consume extensive periods of time before complex patterns are properly fabricated. (Die castings are usually phased in after the pilot run.) In order to cope with these time factors, studies commence at the very preliminary phases of the project in order to establish firm configurations for structural housings and sturdy assemblies. Tooling and patterns are ordered early as feasible even though minor changes are imminent.

Prototype Evaluation

The actions thus far explained encompass the new design preparatory to the fabrication of a practical prototype fabricated with rigidly inspected components and assembled in accordance with applicable drawings and technical data. In instances during fabrication, inspection, or testing, where the prototype technicians discover that the design can be improved from the standpoint of increased reliability, ease of manufacturing, reduced costs, etc., changes are considered by the project team. These skilled technicians are further utilized for their craftsmanship in providing the project team with realistic fits and tolerances, wire dressings, cable lacings, and similar conditions that are eventually incorporated in the drawings released for production. The prototype technicians thereby provide the project team with a three-dimensional verification of the drawings and at the same time assist the methods group in establishing subsequent manufacturing procedures.

A prototype evaluation board, responsible to the president of the company has been established to review new designs and make recommendations for changes or to accept the design in prototype stage. The board has the chief project engineer as its chairman and consists of the department heads of engineering, research, quality control, field service, and manufacturing.

Key Man Is Project Engineer

Under the jurisdiction and guidance of the project engineer the new design progresses from the breadboard stage through the experimental, developmental, service test, prototype, and pilot run phases into production manufacturing. This authority and responsibility vested in the project engineer provides expedient and efficient transfer of information for tooling, test procedures, inspection equipment, assembly methods, and production techniques, as required.

A quality control engineer periodically contacts the project engineer to assist in the preparation of the qualification testing program which includes an analysis of the performance and functional requirements of the applicable specifications and the writing of test procedures and specifics for test fixtures, instruments, and conditions. The quality control engineer acts as a "watch dog" over the prototype during construction, adjustment, operation, and testing.

Upon successful completion of all applicable tests, the project engineer expedites the release of drawings for production. Prior to this, limited releases for the experimental or prototype versions have been paralleled to a certain extent by the controlled release to production of standard parts, definitized assemblies, and, as mentioned previously, long lead time components.

The "secret" to successful accomplishment of routinely converting heretofore non-existent designs into production manufacturing is intelligence and cooperation. Without intelligent scientists, engineers, technicians, and planners, efficient design programs would be impossible. But conscientious, cooperative personnel are also imperative for proper coordination.



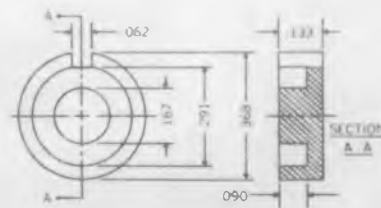
transformer miniaturization
simplified

with

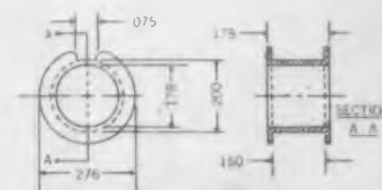
FXC

micro-miniature
potcores

Made of Ferroxcube 3C material, the No. 332P133-3C potcore by FXC is less than $\frac{3}{8}$ " in diameter and successfully eliminates pulse transformer problems created by limitations in weight and space. The coils for this potcore are wound on a specially designed nylon bobbin. The shape of the potcore, combined with the high-permeability material surrounding the windings, gives excellent shielding and effectively minimizes stray fields. The potcores can be placed close together or even stacked, with negligible coupling between coils.



332P133-3C POTCORE



332F175 BOBBIN

Requests for literature and engineering samples should be made on your company letterhead and addressed to:

Applications Engineering Department
FERROXCUBE CORPORATION OF AMERICA
(A subsidiary of North American Philips Co., Inc.)
50 South Bridge Street, Saugerties, New York

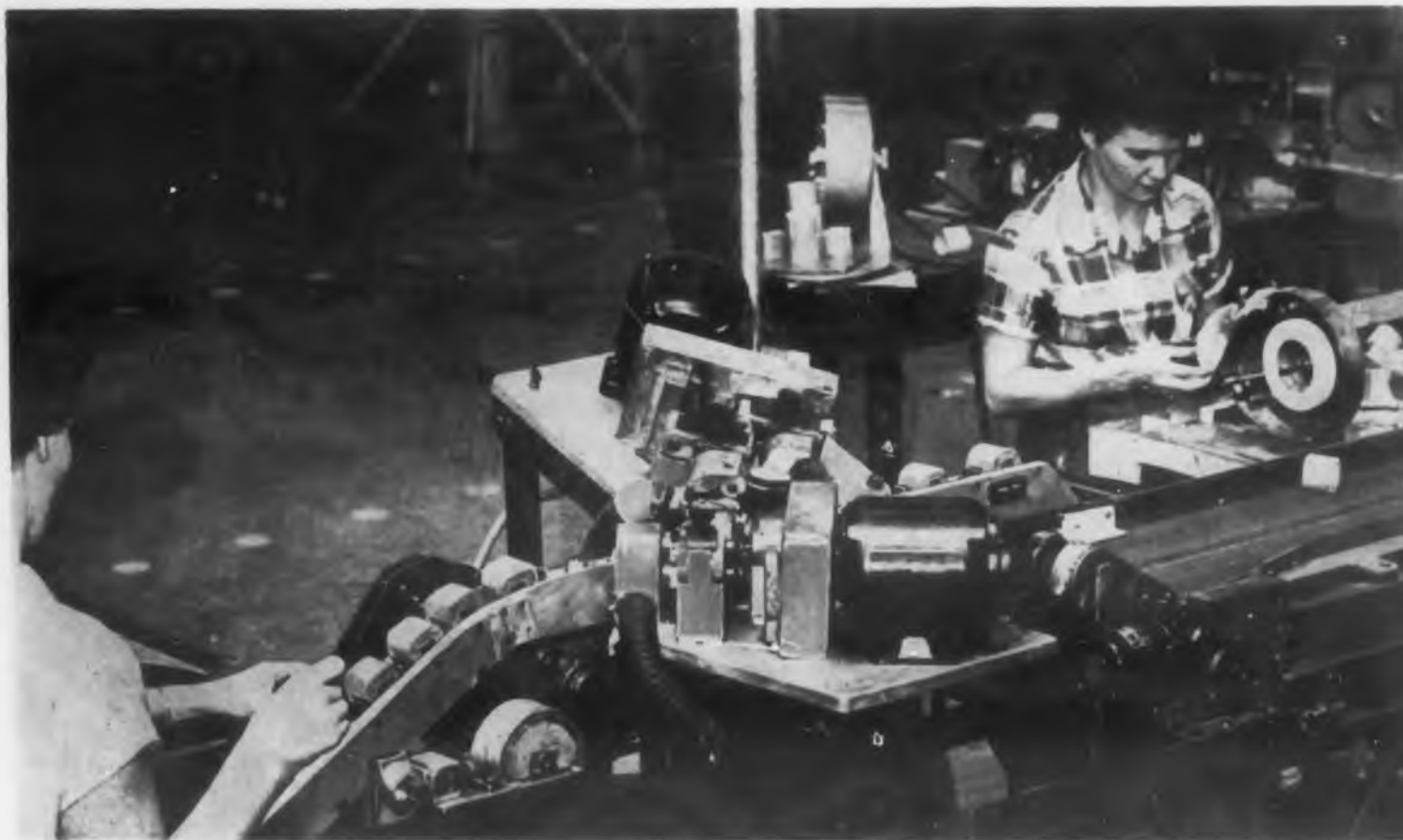
CIRCLE 68 ON READER-SERVICE CARD



Equipment for Low-Cost Production

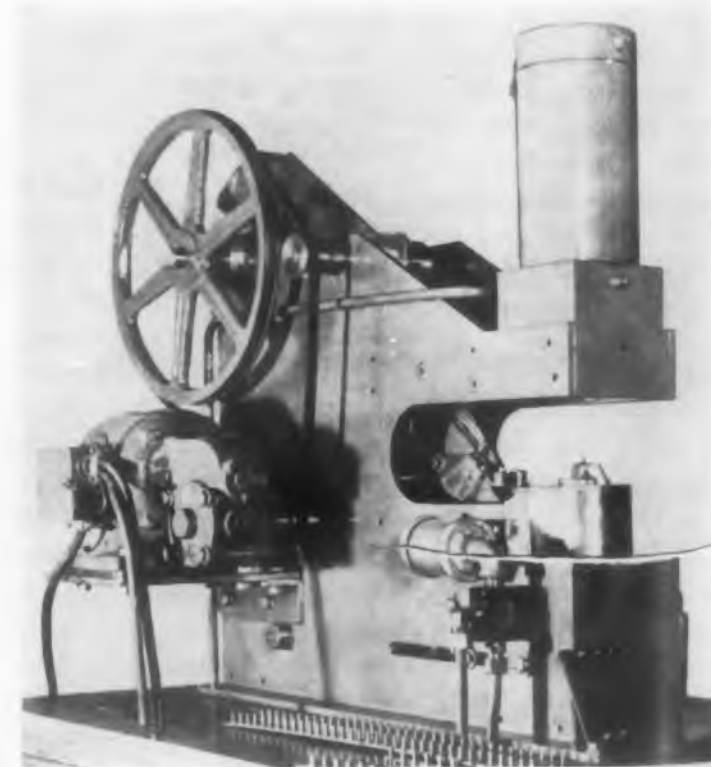
ILLUSTRATED on these pages is production equipment which could reduce product cost if considered in the initial design. An attempt has been made to show the design possibilities and limitations of the equipment. If additional information is needed, circle the appropriate Reader Service Card number.

Wiring and Cabling



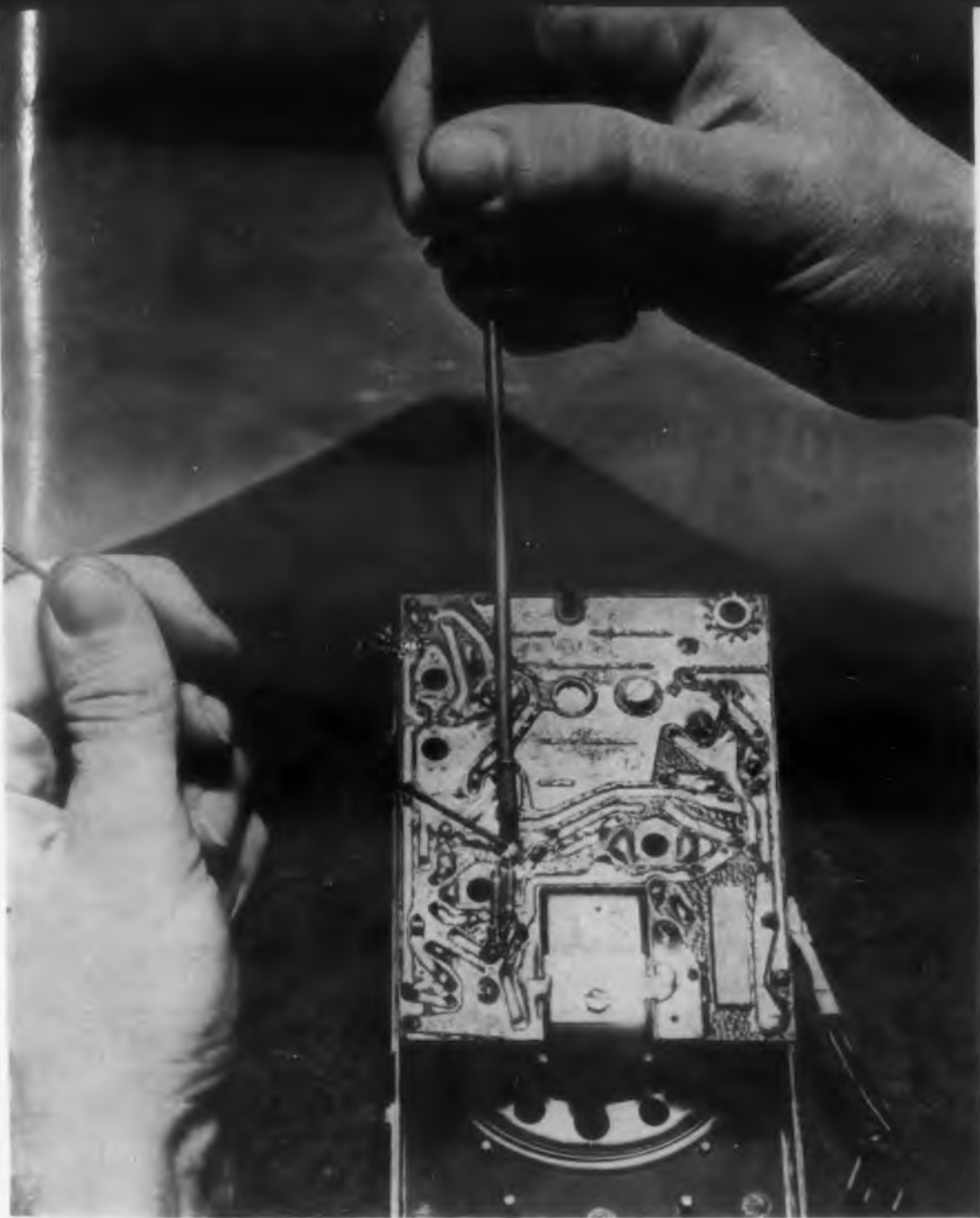
Coil Lead Trimmer: A simple, compact, mechanized wire stripper does a clean, damage free stripping job to required specifications and reduces the human element to a minimum. The device can strip formivar and other coil wire insulations from both leads of more than 1600 coils per hour, and can reduce connection failures to an extremely low figure. The Eraser Co., Dept. ED, 1068 S. Clynton St., Syracuse 4, N. Y.

CIRCLE 69 ON READER-SERVICE CARD



Terminal Setting Machine: This production machine sets turret terminals and tube pins at a rate of 40 per minute, without a miss. It compensates for variations in board thickness and prevents costly part breakage. The machine can be supplied with various raceways as required, and tooling can be interchanged for different applications. Terminals are bottom fed and this permits work to be located on the component before the machine is tripped. Edward Segal, Dept. ED, 72 Spring Street, New York 12, N. Y.

CIRCLE 70 ON READER-SERVICE CARD



Printed Circuit Soldering Iron: This miniature soldering iron was developed for use with miniaturized and printed circuitry. Less than 1-1/2 oz in weight, the iron is designed for production line soldering. Small connections can be soldered inside equipment, with a minimum of heat loss or damage to adjacent wiring, insulation, and terminals. General Electric Co., Dept. ED, 1 River Road, Schenectady, N. Y.

CIRCLE 71 ON READER-SERVICE CARD



Connector Soldering Machine: This soldering machine solders AN type connectors by using the principle of resistance heating. A special carbon electrode, the contact to be soldered, and the switching and indicating system, allow the operator to produce connections in half the time previously required. The use of this machine will eliminate burned insulation and cold solder joints. A light shining through a translucent plastic card shows the operator the correct contacts to solder. Virginia Electronics Co., Dept. ED, River Road, Washington 16, D.C.

CIRCLE 74 ON READER-SERVICE CARD



Wire Cutter and Stripper: This semi-automatic device, when fitted with the proper cartridge, automatically cuts to length and strips both ends of most solid or stranded wire in one operation. The device is air actuated and requires no particular skill to operate. Technical Devices Co., Dept. ED, 2340 Centinela Ave., Los Angeles, California.

CIRCLE 72 ON READER-SERVICE CARD



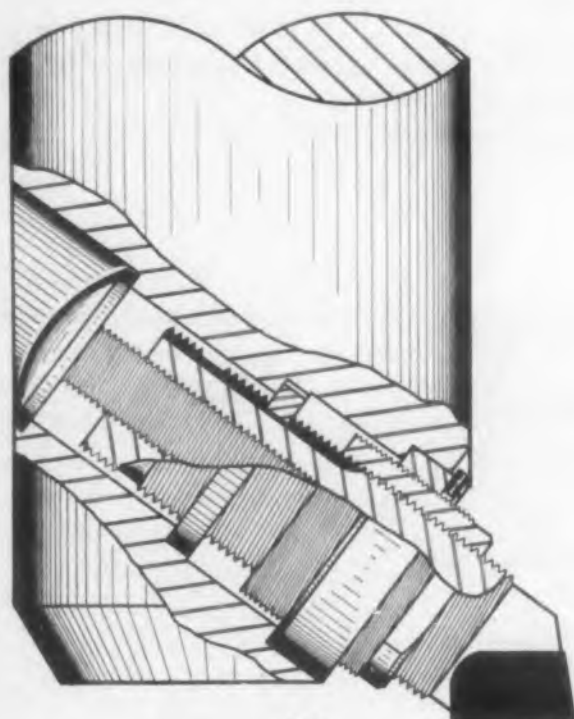
Automatic Feed Eyeletting Machine: This eyeletting machine speeds the production of electronic printed circuits and electrical products. It can be equipped to handle all standard sized eyelets with jam free performance. Eyelets are fed from a large capacity hopper, and the machine can handle work pieces up to 11 in. wide. Stroke length is adjustable to prevent the crushing or marring of fragile materials. Eyelet Tool Co., Dept. ED, 236A Broadway, Cambridge, Mass.

CIRCLE 73 ON READER-SERVICE CARD



Equipment for Low-Cost Production (cont.)

Drilling and Finishing



Precision Cutting Tool Units: This new tool has applications wherever precision boring, turning or other cutting operations are being performed. The tools are easily adapted to multiple or cluster bar installations. With multiple groupings of Calibore units, it is possible to machine several related surfaces at the same time with accuracy and a minimum of down time for adjustments. Units are available in 26 sizes, covering a wide range of boring diameters, from 3/4 in. up. Boring bars are available in a wide range of diameters and lengths with Beaver Quick Change and all other standard shanks. Beaver Tool and Engineering Corp., Dept. ED, 500 West County Rd., Gaylord, Mich.

CIRCLE 75 ON READER-SERVICE CARD

Accurate Drill for Small Holes: This tool is constructed with a special gripping mechanism which permits quick easy changing of dull or broken drills. This feature eliminates the need for costly soldering or brazing of special drill adapters. This tool is excellent for precision drilling of instrument parts, on all types of small intricate mechanisms, including watches and clocks. Ritmar Corp., Dept. ED Huntington, N. Y.

CIRCLE 76 ON READER-SERVICE CARD



Bench-Model Ultrasonic Generator: This generator was designed for use with standard tank type or stainless steel immersible transducers. It is ideal for unattended and quick cleaning of small parts, such as watch mechanisms, jewelry, instruments, transistors and other electronic units, anti-friction bearings, and components that must be dirt-free before assembly. For cleaning-rinsing or other two-step operations, the generator output can be switched easily between transducers mounted in separate tanks. Branson Ultrasonic Corp., Dept. ED, 40 Brown House Road, Stamford, Conn.

CIRCLE 77 ON READER-SERVICE CARD

Cross section of drill head, showing patented double gear train for power transmission.

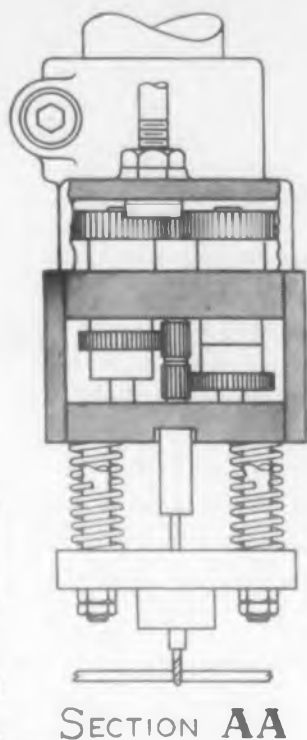
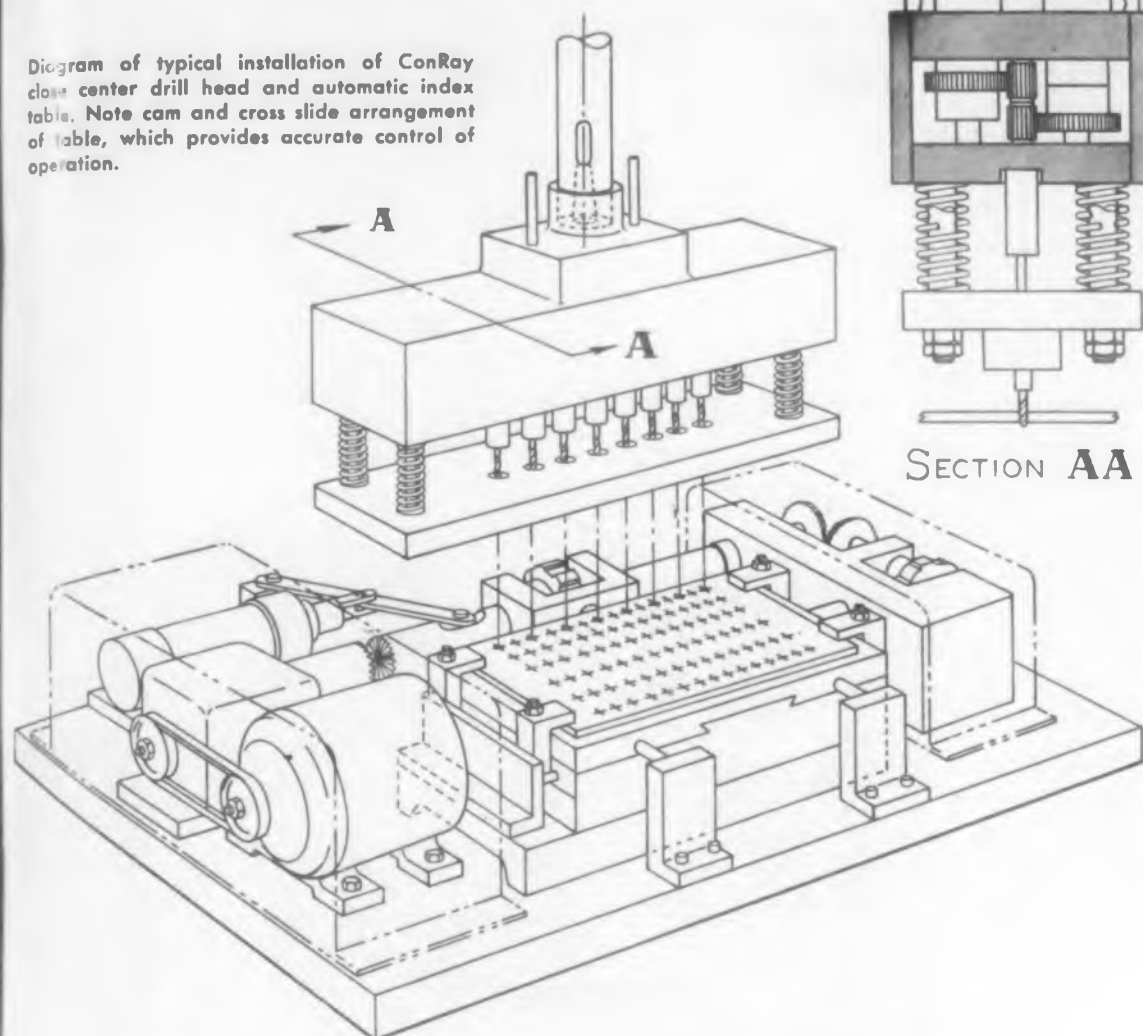


Diagram of typical installation of ConRay close center drill head and automatic index table. Note cam and cross slide arrangement of table, which provides accurate control of operation.



Drill Head Attachment: This unit attaches to a drill press spindle or other source of power and it can produce any type pattern of holes on a close center. It can drill linear, oval, circular, zig-zag, or more complex and irregular arrangements. Work is held in an index table containing two cross slides which regulate the positioning of the work. ConRay Corp., Dept. ED, 29 W. Apple St., Dayton, Ohio.

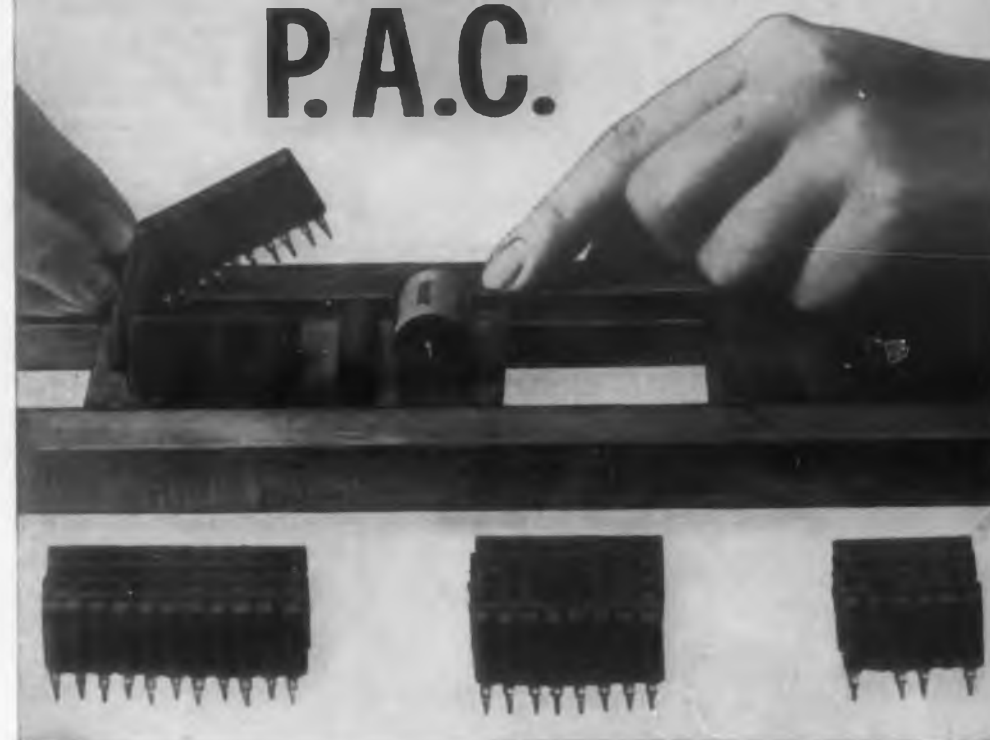
CIRCLE 78 ON READER-SERVICE CARD



Filing Machine: This machine is designed for filing, trimming, and deburring a wide variety of small components. Discs and rings with various teeth arrangements are provided for use at different speeds on an extremely wide variety of materials and finishes. The discs cut without heat, abrasive or coolant, and retain their shape without re-dressing. Newage Industries, Inc., Dept. ED, Jenkintown, Pa.

CIRCLE 79 ON READER-SERVICE CARD

NEW... SPEER P.A.C.



This new Speer Packaged Assembly Circuit offers you a wide variety of custom, preassembled units of high-quality components for use in conjunction with printed board applications.

P.A.C. permits the insertion, as a group, of a full range of capacitors and resistors in simple or complex circuitry. Each P.A.C. is based on components of uniform dimensions, $\frac{1}{8}$ " diameter and $\frac{3}{8}$ " long. Component availability includes Jeffers tubular ceramic capacitors and Speer fixed composition resistors, providing wide circuit flexibility in a single P.A.C. unit.

ADVANTAGES OF SPEER P.A.C.

- Simplifies chassis design and assembly
- Reduces printed circuit board area and insertion operations
- Permits easy and low-cost component change-over to accommodate circuit revisions
- Broad choice of characteristics—low capacitance temperature compensating units and high capacitance bypass capacitors mounted in same P.A.C. unit
- Isolation of individually mounted units provides low shunt capacitance across resistors
- Pretested components achieve unusually close tolerance assembly

Learn more about the new Speer P.A.C.
For information write to:

JEFFERS ELECTRONICS DIV.

Speer Carbon Co. Du Bois, Pennsylvania

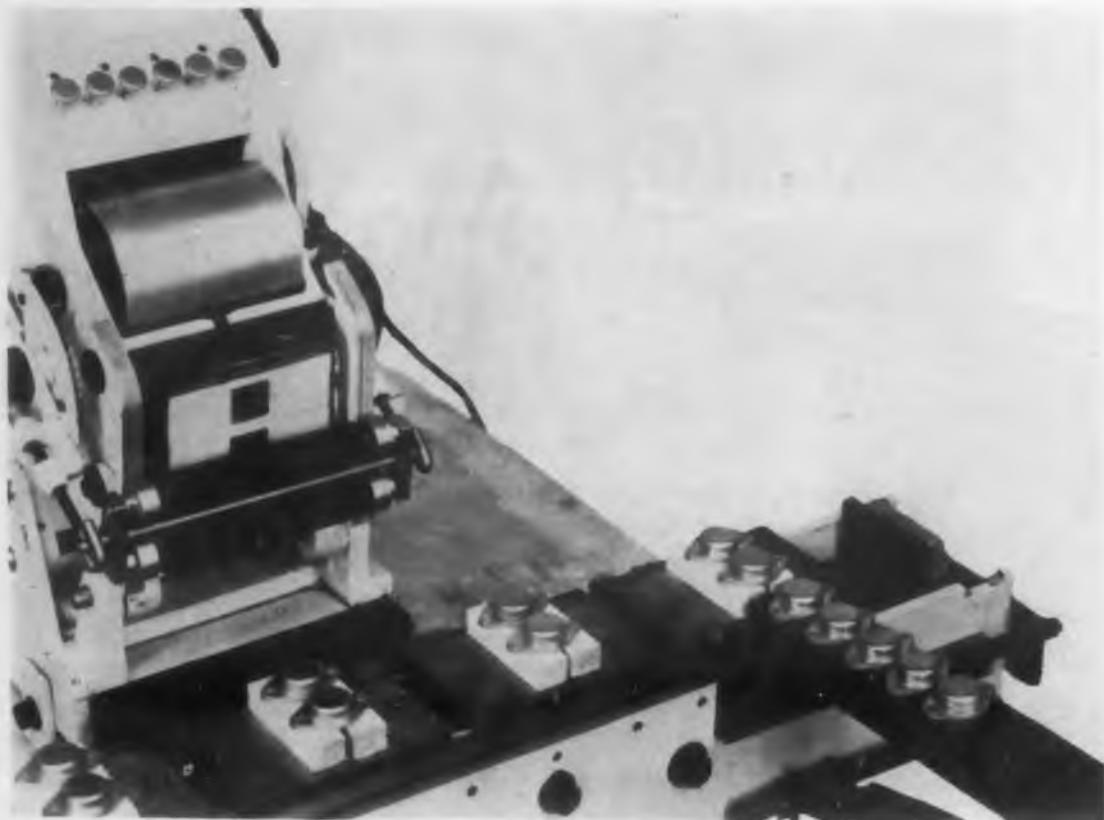
CIRCLE 419 ON READER-SERVICE CARD





Equipment for Low-Cost Production (cont.)

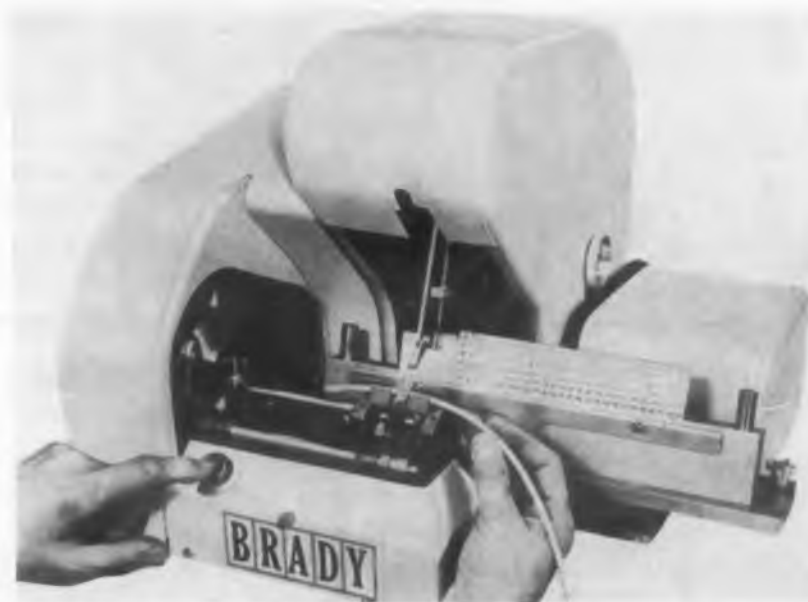
Marking



Component Marking:

Shown in this illustration is a conveyor machine adapted for direct printing onto power transistors, with an output of approximately 4000 pieces per hour. The device will print trademarks and diagrams on components of almost any shape or material. Thirty different models are available to cover all sizes and shapes of objects. Popper and Sons, Inc., Dept. ED, 300 4th Ave., New York 10, N.Y.

CIRCLE 80 ON READER-SERVICE CARD



Automatic Wire Marking Machine: With this machine, an operator can mark 1000 wires per hour. Labels are stripped from a dispenser card and applied to the wire in two seconds. Wires may be coded by number, letter or symbol, consecutively or in series of consecutive groups, without changing the speed or feed of the machine. Additional benefits include a reduction in waste, as every marker is used and the absence of set up, as the machine uses standard cards as a supply for the markers. W. H. Brady, Co., Dept. ED, 727 W. Glendale Ave., Milwaukee, Wisc.

CIRCLE 82 ON READER-SERVICE CARD

Paint and Wipe Machine: This combination paint and wipe machine is used for filling depressed lettering, or characters on switch knobs, buttons and panels. The machine applies paint to the lettering and removes the excess from surrounding areas. Production rated as high as 3000 pieces an hour is possible, and different types of machines are available for different shaped parts. Finish Engineering Co., Inc., Dept. ED, 1115 Cherry Street, Erie, Pa.

CIRCLE 81 ON READER-SERVICE CARD





Versatile Printing Machine: This machine prints on three different levels simultaneously in 1, 2, 3, or more colors, and can accommodate objects up to 5 in. thick, 12 in. wide, and 18 in. long. It handles plastic, metal, wood, glass, or paper items, and can print on raised, round, recessed, concave, convex, or flat objects. Cosom Engineering Corp., Dept. ED, 6012 Wayzata Blvd., Minneapolis 16, Minn.

CIRCLE 83 ON READER-SERVICE CARD



Cylindrical Object Marking: This machine features high speed offset marking of cylindrical, tapered, conical, or wire lead items which can not be chute fed. With this device, and a supply of type inserts, new label designations are available without waiting for new printing plates. Marking inks are available for air drying, baking, and high temperature. Markem Machine Co., Dept. ED, Keene, N.H.

CIRCLE 84 ON READER-SERVICE CARD



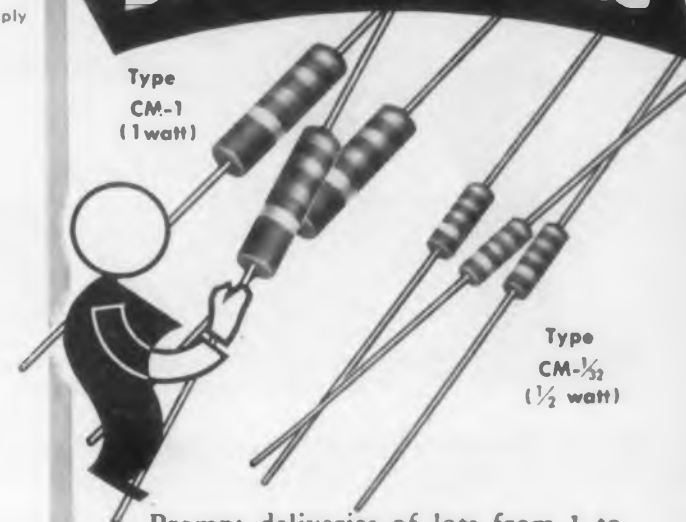
Silk Screen Printing Press: This silk screen printing press was designed for quality production of electronic circuits, panels, and decals. It prints flat material up to 6 in. thick at speeds up to 1000 per hr. Register is achieved by micrometer dials graded in thousandths of an inch. Masterscreen Printing Equipment Corp., Dept. ED, Box 070, Stockton, Calif.

CIRCLE 85 ON READER-SERVICE CARD

ALBANY, N. Y.
E. E. Taylor Co.
BALTIMORE, MD.
Kann-Ellert Electronics Inc.
BINGHAMTON, N. Y.
Morris Distributing Co. Inc.
BOSTON, MASS.
DeMambro Radio Supply
BUFFALO, N. Y.
Radio Equipment Corp.
CANTON, OHIO
Video Wholesale Inc.
CEDAR RAPIDS, IOWA
Gifford-Brown Inc.
CHICAGO, ILL.
Newark Electric Co.
CLEVELAND, OHIO
Pioneer Electronic Supply Co.
COLUMBUS, OHIO
Hughes-Peters Inc.
DALLAS, TEXAS
Wholesale Electronic Supply
DAYTON, OHIO
Srepco Inc.
DES MOINES, IOWA
Radio Trade Supply Co.
EL PASO, TEXAS
Midland Specialty
HAGERSTOWN, MD.
Zimmerman Wholesalers
HARTFORD, CONN.
R. G. Sceli & Co., Inc.
INDIANAPOLIS, IND.
Rodefeld Co., Inc.
INGLEWOOD, CALIF.
Newark Electric Co.
JAMAICA, N. Y.
Norman Radio Dist. Inc.
JOHNSTOWN, PA.
Baker Radio Electric
JOPLIN, MISSOURI
Four State Radio Supply
KANSAS CITY, MO.
Burststein-Applebee Co.
LAFAYETTE, LA.
Ralphs Radio Electronic Supply
LANSING, MICH.
Offenhauer Co.
LOUISVILLE, KY.
Sutcliffe Co.
MANSFIELD, OHIO
Wholesaling Inc.
MILWAUKEE, WIS.
Radio Parts Co., Inc.
MOUNTAIN SIDE, N. J.
Federated Purchaser
NEWTON, MASS.
Leonard Greene Shaw Co.
NEW YORK, N. Y.
Arrow Electronics Inc.
NEW YORK, N. Y.
Electronic Center
NORFOLK, VA.
Radio Equipment Co.
OAK PARK, ILL.
Melvin Electronics Inc.
OKLAHOMA CITY, OKLA.
Electronic Supply Co.
PASADENA, CALIF.
Electronic Supply Corp.
PHILADELPHIA, PA.
Almo Radio Co.
RICHMOND, VA.
Meridian Electronic Equip. Co.
SAGINAW, MICH.
Saginaw Distributors Inc.
ST. LOUIS, MO.
Van Sickle Radio Corp.
SCRANTON, PA.
Fred P. Pursell
SEATTLE, WASH.
Western Electronic Supply Co.
SPRINGFIELD, ILL.
Suter T. V. Supply Inc.
SPRINGFIELD, MASS.
Soundco Electronic Supply Co.
SYRACUSE, N. Y.
Morris Distributing Co., Inc.
TAMPA, FLA.
Thurow Distributors, Inc.
TRENTON, N. J.
The Dragon Co.
TULSA, OKLA.
S & S Radio Supply Co.
TUCSON, ARIZ.
Elliot Electronics Inc.
UTICA, N. Y.
Beacon Electronics
WASHINGTON, D. C.
Electronic Wholesalers Inc.
WATERBURY, CONN.
Bond Radio Supply
WICHITA, KAN.
Interstate Electronic Supply Corp.

When you need
fixed resistors
in a hurry...

ORDER FROM
THESE LOCAL
STACKPOLE
DISTRIBUTORS



Prompt deliveries of lots from 1 to 1,000—all military and RETMA preferred resistance values and tolerances. Fixed composition types that meet or surpass critical performance requirements.

**STACKPOLE
RESISTORS**

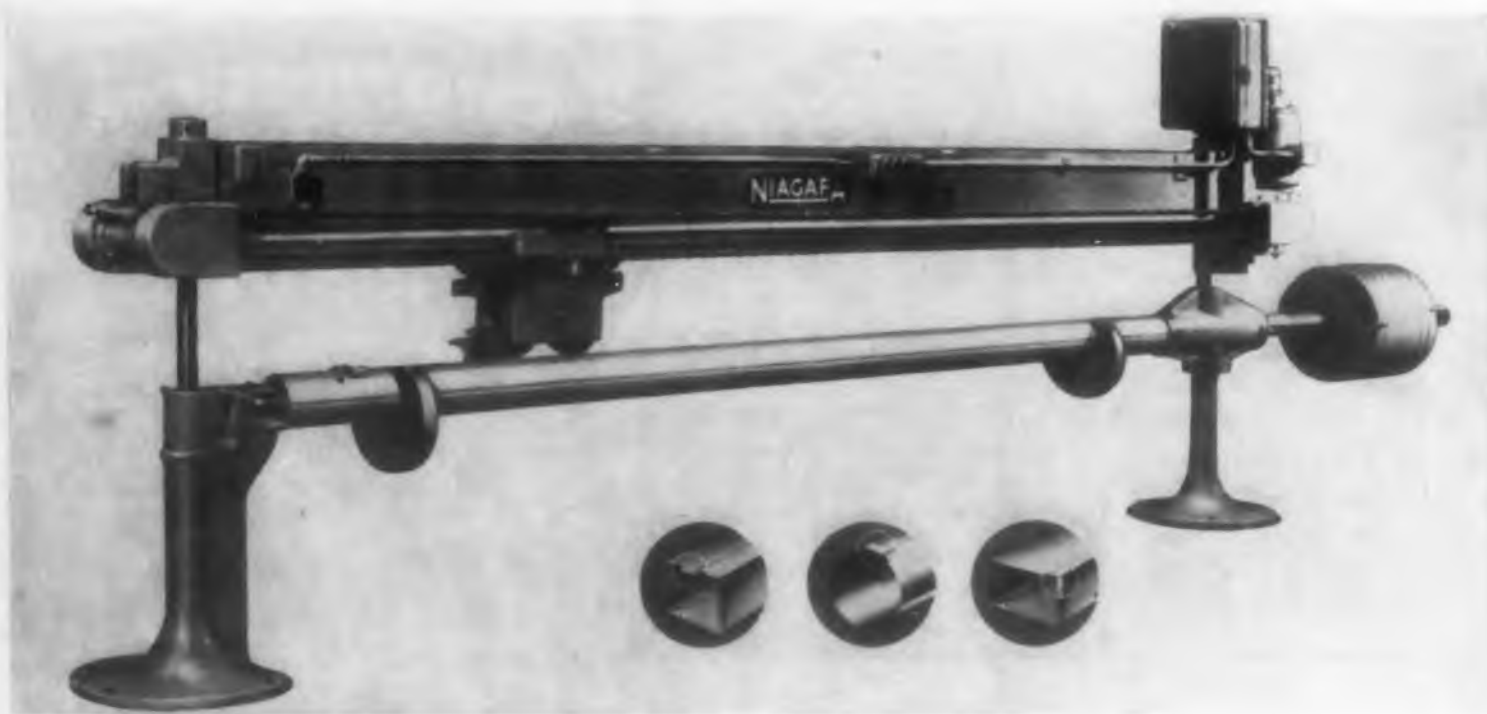
First choice of leading users
since the early days of radio.

Distributors' Division
STACKPOLE CARBON COMPANY
26 Rittenhouse Place, Ardmore, Pa.

CIRCLE 420 ON READER-SERVICE CARD

Equipment for Low-Cost Production (cont.)

Metal Fabricating



Pushbutton Power Groover: Power is supplied to this groover by a direct-connected reversible gearhead motor. A built-in brake stops the carriage quickly for rapid return stroke and the carriage is returned to the starting position automatically by means of a limit switch. Eight models are available for single or Pittsburgh lock seaming, and groovers can be obtained with working lengths from 4 to 10 ft for handling mild steel up to 16 ga. Niagara Machine & Tool Works, Dept. ED, 683 Northland Ave., Buffalo 11, N.Y.

CIRCLE 86 ON READER-SERVICE CARD

Ring and Circle Shear: Finger-tip control and power downfeed bring ease of operation to this ring and circle shear. Developed to make commercially perfect circles, and circular holes and rings, the machine has a capacity of 1/4 in. mild steel. Conveniently located push-buttons simplify cutter and downfeed operation. Cutter descent can be stopped at any depth, and overtravel of the cutter in any direction is prevented by limit switches. Niagara Machine and Tool Works, Dept. ED, Buffalo 11, N. Y.

CIRCLE 87 ON READER-SERVICE CARD



Punch Press Adaptor: This device can be used to convert a punch press to a template or prototype manufacturing tool. It allows the operator to raise or lower the punch to the workpiece without moving the press ram. This feature allows for exact alignment of the punch and hole location before the press is tripped. Standard tools may be used with the unit, and quick set up changes are possible. Buck Engineering Co., Inc., Dept. ED, 37-41 Marcy Street, Freehold, N. J.

CIRCLE 88 ON READER-SERVICE CARD



What's *new* for you in **CANNON PLUGS**



Turret Punch Press:

This punch press enables an operator to punch different sized holes in sheet material by selecting the proper turret on the machine. Fine burr-free tolerances are maintained, due to the positive alignment between punch and die. Capacity of the press is four tons, and it can punch a 2 in. hole 16 ga mild steel to a 1/4 in. hole in 3/16 in. steel plate. O'Neil-Irwin Mfg. Co., Dept. ED, 539 Eighth Ave., Lake City, Minn.

CIRCLE 89 ON READER-SERVICE CARD



DPJ-33S



DPG-34P

- ▶ **Vibration**
 - ▶ **Moisture**
 - ▶ **Pressure**
- ▶ PROTECTION**

with new **DPJ and DPG Connectors**

New DPJ and DPG Connectors feature sealing by means of a rubber seal around the insert faces. Exceptionally good protection against vibration and undesirable pressure and moisture conditions is provided. The DPG currently is available in 5 different insert arrangements, the DPJ with 3 insert layouts. Write for Bulletin DP-101 TODAY!

new

"EX" SEALED CONNECTORS

- ▶ **No Potting Required**
- ▶ **Light weight**



New EX Connectors feature a monobloc silicone insert into which the contacts are inserted after wiring. When the endbell is tightened over the insert, the contacts are completely sealed . . . giving a sealed connector of minimum weight without potting.

EX plug assemblies are currently available in four shell configurations with socket contact inserts . . . EX05, EX06, EXG06 and EX08. They are basically identical with the exception of endbell variations in each case. EX plugs mate and seal with standard AN, AN-E, and GS type receptacles, and are available in practically all AN layouts using #12 or #16 contacts from sizes 8S to 28. Write for Bulletin PR-EX TODAY!

new



Available in square-flanged receptacle, Q02, and straight plug, Q06. Insert Diameters: 3/16", 1/4", and 3/8".

"Q" MINIATURE CONNECTORS

- ▶ **Self-Locking**
- ▶ **Sealed**
- ▶ **Vibration Resistant**

Designed for control and instrumentation circuits of all types where space, vibration, moisture, or pressure conditions are limiting factors. Resilient grommets seal behind inserts . . . rubber sealing ring seals around the insert faces. Locking engagement accomplished by a beryllium copper latch within a spring loaded sleeve. Three shell sizes, with 7, 13, 19, 37 silver-plated brass 10-amp. contacts for #18 AWG wire. Alternate positioning, Cymel 592 insulators. External parts are cadmium plated aluminum. Hermetically-sealed, round-flanged receptacle, QH25, also available. Write for Q Miniature Bulletin TODAY!

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, California.
Factories in Los Angeles, Salem, Mass., Toronto, London, Melbourne.
Manufacturing licensees in Paris, Tokyo. Representatives and distributors in all principal cities.

CIRCLE 421 ON READER-SERVICE CARD



Please Refer to Dept. 143

MILGRAY ELECTRONICS

distributors of
electronics
to industry

offers you

all these



Texas Instruments
semiconductors

in 1-99 quantities

at factory prices

off-the-shelf

for overnight

delivery



MILGRAY
ELECTRONICS
INCORPORATED

136 Liberty Street
New York 6, N.Y.

Phone:
REctor 2-4400

CIRCLE 100 ON READER-SERVICE CARD



Design for **LOW-COST PRODUCTION**

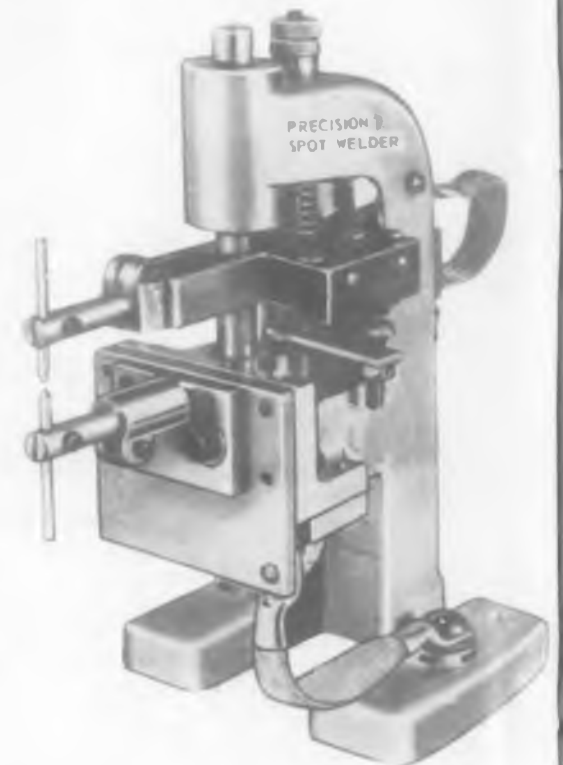
Equipment for Low-Cost Production (cont.)

Assembly Tools



Double Drive Riveter: This device automatically feeds and sets two rivets at the same time. The rivets may be of different lengths and head diameter specifications. An easy-trip mechanism actuates the machine while a non-repeat single revolution clutch makes it safe and simple to operate. Tubular Rivet and Stud Co., Dept. ED, Wollaston 70, Mass.

CIRCLE 90 ON READER-SERVICE CARD



Vertical Bench Spot Welder: The main advantage of this welding machine is the accurately ground vertical shaft which moves up and down in ball bearings making the movement sensitive, accurate, and sturdy. The units are available in ratings from 1/2 to 5 kva, and are supplied with timing devices and transformers. Eisler Engineering Co., Inc., Dept. ED, 750 S. 13th Street, Newark 3, N. J.

CIRCLE 91 ON READER-SERVICE CARD



Screw Holding Driver: This device can save at least 50 per cent of production time in the seating of screws in hard to reach places. The assembler pushes the device into the screw slot and the screw is held firmly. This tool is manufactured in a range of sizes and lengths to suit every requirement. The H. J. J. Co., Dept. ED, 268 Marlow Drive, Oakland, Cal.

CIRCLE 92 ON READER-SERVICE CARD

CIRCLE 198 ON READER-SERVICE CARD

Complete listings of

TI
SEMICONDUCTORS,
RESISTORS AND
PANEL INSTRUMENTS

pull out and file
for
ready reference



For complete information on
TI products, contact
the office nearest you:

REGION OFFICES

EASTERN REGION

99 Park Avenue
New York 16, New York
Region Sales Manager: Deak Atkinson
MUrray Hill 2-7951

MID-AMERICA REGION

4104 N. Harlem Avenue
Chicago 34, Illinois
Region Sales Manager: Dick Hanschen
NAtional 5-8330

WESTERN REGION

1741 Ivar Avenue
Los Angeles 28, California
Region Sales Manager: Bill Brugman
HOLlywood 2-6977

SOUTHERN REGION

P. O. Box 312, Dallas, Texas
Field Sales Manager: J. Rodney Reese
LAKeside 8-0391

SALES OFFICES

53 Queen Street
Ottawa 4, Ontario, Canada
Sales Engineer: Earl Johnson
Central 6-3430

701 Wilson Building
Camden 2, New Jersey
District Sales Manager: Bob Himmel
WAInut 5-9878

Monument Building
Dayton 2, Ohio
Sales Engineer: Lou Karagianis
FULton 5801

431 Bulkeley Building
Cleveland 14, Ohio
Sales Engineer: Bill Dorn
CHerry 1-8144

1413 K Street, NW
Washington, D. C.
Sales Engineer: Ken Davis
STERling 3-5865

Vernon Building
62 Prospect
Waltham 54, Massachusetts
Sales Engineer: Al Rich
TWINbrook 3-2052

317 State Tower Building
Syracuse 2, New York
Sales Engineer: Tom Connors
GRAnite 1-4041

529 East Ohio Street
Denver 9, Colorado
Sales Engineer: Harvey Weyrick
PEARl 3-3222

T/I SILICON DIODES AND DIODE/RECTIFIERS



GENERAL PURPOSE

Type	Max Reverse Working Voltage	Min Junction Break-down Voltage*	Min Forward Current 25°C	Max Ratings at 25°C			Max Ratings at Elevated Temperatures			Typical Capacity $\mu\mu\text{f}$ $f=100\text{kc}$ Temp - 25°C $V_R = -12\text{V}$		
				Reverse Current†	Dissipation	Avg Rectified Forward Current	Ambient Temp	Reverse Current†	Dissipation		Avg Rectified Forward Current	
			mA	μA	mW	mA	°C	μA	mW	mA		
600C		30	3	1	8 ($\alpha = -10\text{V}$)	100	25	100	20 ($\alpha = -10\text{V}$)	40	15	2.5
601C		50	3	1	0.04 ($\alpha = -10\text{V}$)	100	25	150	40 ($\alpha = -10\text{V}$)	20	10	2.5
604C	4.7	5.5	60	1	0.1	150	100	150	50	40	40	20
606C	6.8	7.5	35	1	0.1	150	90	150	50	40	35	16
608C	10	11	25	1	0.1	125	75	150	50	20	25	12
610C	15	17	12	1	0.1	125	60	150	50	20	20	7
612C	22	25	7	1	0.1	125	50	150	50	20	20	5
614C	33	37	5	1	0.1	125	35	150	50	20	15	3.5
616C	47	52	3	1	0.2	100	30	125	40	20	15	2.5
618C	68	75	1.5	1	0.2	100	25	125	40	20	10	2
620C	100	110	0.9	1	0.2	100	20	125	40	20	8	1.4
622C	150	170	0.5	4	0.2	90	15	100	30	30	5	1.2
624C	220	250	0.3	4	0.4	80	10	71	20	40	5	1
1N645	225	275	400	1	0.2	600	400	100	15		150	9
1N646	300	360	400	1	0.2	600	400	100	15		150	9
1N647	400	480	400	1	0.2	600	400	100	20		150	9
1N648	500	600	400	1	0.2	600	400	100	20		150	9
1N649	600	720	400	1	0.2	600	400	100	25		150	9

Max Reverse Recovery Time μsec

COMPUTER DIODES

1N659	50	60	0.3	5	100	100	25	30	2.7
1N660	100	120	0.3	5	100	100	50	30	2.7
1N661	200	240	0.3	10	100	100	100	30	2.7

VOLTAGE REFERENCE * *



Type	Rev Breakdown Voltage at 25°C (measured at 5 mA reverse current)		Max Total Power Dissipation mW		Min Forward Current at 25°C at +1V mA	Max Average Rectified Forward Current mA		Max Reverse Current at -1V μA	
	(min)	(max)	at 25°C	at 150°C		at 125°C	at 150°C	at 125°C	at 150°C
650C	3.7	4.5	150	40	125	125	50	0.1	20
651C	4.3	5.4	150	40	100	120	45	0.1	20
652C	5.2	6.4	150	40	75	110	40	0.1	20
653C	6.2	8	150	40	60	100	40	0.1	20
654C9	8.5	9.5	150	40	60	100	40	0.1	20
655C9	9.5	10.5	150	40	60	100	40	0.1	20

* Measured at 0.1 mA. Current increases rapidly above this point.
† At maximum working voltage except for Types 600C and 601C.
‡ On types 604C, 606C and 608C reverse voltage was reduced below breakdown voltage.

§ At 100°C.
¶ Recovery time to 400K in JAN 256 test circuit.
** All low voltage reference diodes are available with $\pm 5\%$ tolerances between 3.7 and 10 volts.



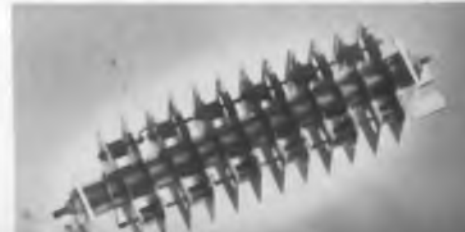
T/I SILICON RECTIFIERS

Type	Welded Case	Application	Recurrent Peak Inverse Voltage V		Average Rectified Forward Current at Max PIV mA (except as noted)		Recurrent Peak Current 55°C to +150°C* 65°C to +150°C† mA (except as noted)	Altitude at Max Rating (Ft)	Avg Output Current Full-Wave Operation -55°C to +150°C mA	AC Anode Voltage (per section) -55°C to +150°C V
			at 25°C	at 150°C	at 25°C	at 150°C				
1N588	Axial	HV Half-Wave	1500	1000	25	10	150*	70,000		
1N589	Axial	HV Half-Wave	1500	1000	50	25	250*	70,000		
1N1130	Cathode Stud	HV Half-Wave	1500	1000	300	150	900†	70,000		
1N1131	Anode Stud	HV Half-Wave	1500	1000	300	150	900†	70,000		
T/I-680	Plug-in††	HV Full-Wave	1500	1000					50	350
1N538	Axial	Half-Wave	200	200	750	250	2.5 A at 25°C	100,000		
1N539	Axial	Half-Wave	300	300	750	250	2.5 A at 25°C	100,000		
1N540	Axial	Half-Wave	400	400	750	250	2.5 A at 25°C	100,000		
1N1095	Axial	Half-Wave	500	500	750	250	2.5 A at 25°C	100,000		
1N1096	Axial	Half-Wave	600	600	750	250	2.5 A at 25°C	70,000		
1N1124	Cathode Stud	Half-Wave	200	200	2.5A	750	7.5 A at 25°C	70,000		
1N1125	Cathode Stud	Half-Wave	300	300	2.5A	750	7.5 A at 25°C	70,000		
1N1126	Cathode Stud	Half-Wave	400	400	2.5A	750	7.5 A at 25°C	70,000		
1N1127	Cathode Stud	Half-Wave	500	500	2.5A	750	7.5 A at 25°C	70,000		
1N1128	Cathode Stud	Half-Wave	600	600	2.5A	750	7.5 A at 25°C	70,000		

†† Solder—seal

DIFFUSED SILICON RECTIFIER STACKS

From TI... with amperage ratings ranging from 1.5 amps to 18 amps and DC output voltages from 15 to 1500 volts! Now available in half-wave, full-wave and bridge configurations for single phase and polyphase circuitry.





**T/I
SILICON
TRANSISTORS**

for increased design freedom, economy and reliability

select from the industry

available to you on rapid delivery, in mass-production quantities
of scores of commercial and military circuits.



For your high temperature applications, TI silicon transistors are available in a choice of soldered cases for use in existing equipment, oval welded cases to meet U.S.N. specs, and round welded cases for new designs.

2 NEW MEDIUM POWER UNITS!

- TYPE 2N497 ($BV_{CBO} = 60$ V)
- TYPE 2N498 ($BV_{CBO} = 100$ V)
- 4 W at 25°C; 1 W at 150°C •
- 20-Ohm saturation resistance •
- 65°C to +200°C operation and storage •
- Temperature stabilized at 215°C •
- JETEC 30 package • Bulletin DL-S 840

	1.	2.	3.	Dissipation at 25°C W	Small Signal Current Transfer Ratio h_{fe}		Collector Current I_c mA (max.)	DC Current Transfer Ratio h_{FE}		Collector Breakdown Voltage-V BV_{CBO} (min.) (max.)	Saturation Resistance R_{cs} Ohms (max.)	Alpha Cutoff Frequency $f_{\alpha b}$ mc (min.)
					(min.)	(max.)		(min.)	(max.)			
small signal 	903	2N117	2N332	0 150	9	20	25			30 45	300	1
		USN2N117										1
	904	2N118	2N333	0 150	18	40	25			30 45	300	2
		USN2N118										2
	904A	2N118A	2N334	0 150	18	90	25			30 45	300	8
	905	2N119	2N335	0 150	36	90	25			30 45	300	2
USN2N119		2										
910		2N336	0 150	76	333	25			30 45	300		
switching 			2N337	0 125			20	20	55	40	300	10
			2N338	0 125			20	45	150	40	300	20
high frequency 			3N32	0 125			10	Power Gain: 20 db (min.) at 4 3 mc				
			3N33	0 125			10	Power Gain: 18 db (min.) at 12 5 mc				
			3N34	0 125			10	Power Gain: 16 db (min.) at 30 mc				
			3N35	0 125		8 (typ.)	10	Power Gain: 20 db (typ.) at 70 mc				
medium power 	951		2N339	0 750	1	9				50 55	300	
	952		2N340	0 750	1	9				80 85	350	
	953		2N341	0 750	1	9				120 125	400	
	2N243		2N342	0 750	1	9	32	60		60	350	
	2N244		2N343	0 750	1	28	90	60		60	350	
power 	970			8 75				140	3	120	200	
high power 	2N424			37 5		10 (large signal)		2A	8	60	10	
	2N389			37 5		10 (large signal)		2A	10	60	6	









TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 312 • DALLAS, TEXAS

**ONE YEAR GUARANTEE ON ALL
T/I SEMICONDUCTORS**

Industry's widest line...

T/I GERMANIUM TRANSISTORS

quantities, for the complete transistorization

	Former Designation	Dissipation at 25°C mW	Collector Voltage-V (max.)	Collector Current mA (max.)	Beta		Conversion Gain db		IF Gain db		Audio Gain db		Power Gain db (min.)	Alpha Cutoff Frequency mc (avg.)
					(min.)	(max.)	(min.)	(max.)	(min.)	(max.)	(min.)	(max.)		
VHF tetrode pnp 	3N25	501	25	-15	-2	65 (des. cen.)							10@100mc	200
high frequency pnp 	2N248		30	-25	-5	20 (des. cen.)							10@18mc	50
radio converter and IF  npn	2N253		65	12	5					28	32 at 455 kc			
	2N254		65	20	5					32	36 at 455 kc			
	2N172	830	65	16	5			22	28					
	2N145		65	20	5					30	33 at 455 kc			
	2N146		65	20	5					33	36 at 455 kc			
	2N147		65	20	5					36	39 at 455 kc			
	2N148		65	16	5					32	35 at 262.5 kc			
	2N149		65	16	5					35	38 at 262.5 kc			
	2N150		65	16	5					38	41 at 262.5 kc			
	2N148A		65	32	5					32	35 at 262.5 kc			
	2N149A		65	32	5					35	38 at 262.5 kc			
	2N150A		65	32	5					38	41 at 262.5 kc			
	2N252		30	-16	-5			30	—					
	2N308	375	30	-20	-5					39	42 at 455 kc			
	2N309	376	30	-20	-5					41	44 at 455 kc			
2N310	377	30	-30	-5					37	—	28*	—		
audio output pnp  	2N185	352	150	-20	-150							Class A: 39 Class B: 26	—	
	2N238	310	50	-20								37	42	
	2N291	357	300	-25	-200							Class A: 31 Class B: 22	—	
general purpose npn  pnp	2N364	200A	150	30	50	9	19							2.5
	2N365	201A	150	30	50	19	49							3
	2N366	202A	150	30	50	49	—							3.5
	2N367	300	150	-30	-50	9	19							0.7
	2N368	301	150	-30	-50	19	49							1
	2N369	302	150	-30	-50	49	—							1.3
power pnp 	2N250	356	25W	-30	-3A	30	Class B Power Output: 10W					Class A 30		
	2N251	356A	25W	-60	-3A	30	Class B Power Output: 40W					Class A 30		
	2N456		35W	-40	-5A	30						Class A 34 Avg.		
	2N457		35W	-60	-5A	30						Class A 34 Avg.		
phototransistor npn 	800		65	20	5									

* Audio voltage gain = $\frac{E_{Out}}{E_{In}}$ in recommended circuit



Power Screwdriver: This power screwdriver is a production tool designed to automatically hopper-feed and drive screws. It can be installed in an automatic set up, or in a multiple unit system. The driver features predetermined torque settings and foot pedal control and it can handle no. 2 to 1/4 in. screws of varying length. Illinois Tool Works, Power Tool Division, Dept. ED, 2501 N. Keeler Avenue, Chicago, Ill.

CIRCLE 93 ON READER-SERVICE CARD



Multiflame Brazzer: This equipment provides automatic and semi-automatic brazing and soldering equipment. A moving belt carries the assemblies through a loading zone, a heating zone, a cooling zone, and then automatically discharges the finished assemblies. The equipment can be used to braze and solder all types of electronic hardware, including R. F. and A. N. connectors, condensers, and resistors. Younger Brothers, Dept. ED, Water Street, Brunswick, Me.

CIRCLE 94 ON READER-SERVICE CARD



Portable Automatic Screwdriver: This automatic portable power screwdriver installs driving machine screws, sheet metal screws, thread-cutting screws, SEMS (preassembled screw and washer), and wood screws. It will hold screws firmly until started and then drive them from any angle. Screws are supplied by a visible load cartridge. The tool is powered through a single lightweight air hose on conventional air pressure. Torque is adjusted simply and bits can be changed without special tools. Illinois Tool Works, Power Tools Div., Dept. ED, 2501 N. Keeler Avenue, Chicago 39, Ill.

CIRCLE 95 ON READER-SERVICE CARD

CIRCLE 198 ON READER-SERVICE CARD



EVERYTHING UNDER CONTROL WITH GUARDIAN TELEPHONE RELAYS



GUARDIAN SERIES 405 D.C.

**High Reliability • Superior Quality
Minimum Adjustment • Long Life**

This Guardian Series 405 D.C., Telephone Relay, tested to critical gauging and adjusting practices, performs with utmost reliability at high speeds under rigorous operating conditions. It challenges comparison, is completely *interchangeable* with all standard telephone relays. Arrange for delivery of production samples. Make your own tests. Coils are single, double, or triple wound. Precision time-delays available on release or attract. Switching arrangements, contact sizes and materials to your specifications.

MORE POWER in LESS SPACE

- Pin Hinged Armature Reduces Friction
- Sensitive With Low Operating Power
- Designed for Base Mounting
- Terminals Accessible for Easy Wiring

Additional Guardian Telephone Relays Available
in Many A.C. and D.C. Versions



Write — Submit Your Requirements for
Specific Recommendations

GUARDIAN  **ELECTRIC**
1622-M W. WALNUT STREET CHICAGO 12, ILLINOIS
CIRCLE 101 ON READER-SERVICE CARD

Equipment for Low-Cost Production (cont.)

Processing Tools



Slicing and Dicing Machine: This machine provides a precision method for production slicing and dicing of brittle hard or friable materials. Specifically built originally for automatic operation in the production of transistors, the machines are now available with facilities and accessories for machining a wide variety of materials. Do All Company, Dept. ED, 254 N. Laurel Ave., Des Plaines, Ill. CIRCLE 96 ON READER-SERVICE CARD

Lapping Technique for Crystals: A new diamond fixture attached to a Lapmaster machine can produce a flatness under three lightbands along with extreme parallelism and thinness. The technique is used in the production of germanium, silicon, quartz, barium titanate, and lead zirconate crystals and wafers. The diamond stops can be set to μ inch accuracy to provide the desired crystal blank finish thickness. Crane Packing Co., Dept. ED, 6400 Oakton St., Morton Grove, Ill.

CIRCLE 97 ON READER-SERVICE CARD



Vacuum Annealing Furnace: This versatile, completely self-contained unit can be converted into a melting furnace. One basic unit provides the user with a complete installation for vacuum processing at a fraction of the cost and space normally required. The basic unit is a double pumped muffle type vacuum annealing furnace with a hot zone of 6 by 12 in. It can operate continuously at 2150 F at a pressure of 1×10^{-4} mm Hg. High Vacuum Equipment Corp., Dept. ED, Hingham, Mass.

CIRCLE 98 ON READER-SERVICE CARD

MICROWAVE PROGRESS

Signal Sources and Receivers

What a tankful of gasoline is to the automobile, the klystron tube is to the microwave system—a reliable and efficient power source.

Internal and external cavity type klystrons are used in PRD microwave oscillators. Both types belong to the reflex klystron group which is usually preferred because it provides easy tuning over a relatively wide frequency range and easy frequency or amplitude modulation.

The coaxial cavity is most often used for broadband oscillators since its principal mode is the *TEM*. This permits greater frequency coverage than either the *TE* or *TM* modes of rectangular waveguide sections.

PRD's line of signal sources is conveniently operated through the use of PRD Klystron Power Supplies. Electronically regulated beam, grid, and reflector voltages provide extremely stable klystron output signals.

A spectrum analyzer is a special type of self-contained receiver. It presents an instantaneous display of the power spectrum of the input r-f pulse on an oscilloscope screen. Basically, it is a superheterodyne receiver with a frequency modulated local oscillator.

While the analyzer delivers an accurate envelope of the pulse frequency spectrum, it does not necessarily display each frequency component, since the frequency separation between adjacent spectral lines on the screen is a function of the local oscillator sweep rate, f_s , as well as the PRF, f_R . Actually, the number of lines produced on the screen is f_R/f_s . By varying f_s , the operator can control the spectrum detail presented.

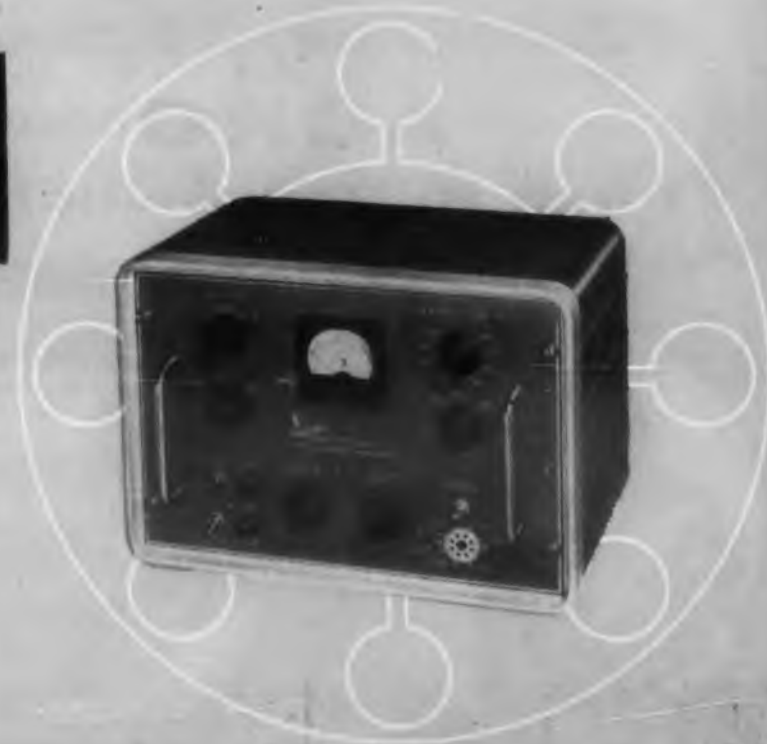
Data such as that contained in the foregoing paragraphs are available in our PRD Reports. Published periodically, these reports give practical information on virtually every aspect of microwave research and engineering. Mathematical derivations, graphs, and charts are always included. If you'd like to receive these reports (there's no charge of course), we'll be happy to add your name to our mailing list. Please address your request to: Reports Dept. R-24.



Polytechnic Research and Development Co., Inc.

202 Tillary Street • Brooklyn 1, N. Y. • Tel: UL 2-6800

Cable Address: MICROWAVE, NEW YORK



PRD Klystron Power Supply for low and medium voltage klystron tubes

Three Protective Devices Prevent Klystron Burn-out!

Another first from PRD. A compact, easily transportable klystron power supply that provides: a protective diode to safeguard the reflector against turning more positive than the cathode; a fuse in the klystron cathode return to protect the beam supply; and a "Beam Off" position to allow for warming up of the klystron filament.

A special feature of Type 809 Klystron Power Supply eliminates readjustments when changing from cw to square wave modulation. The top of the square wave is automatically clamped to the previously chosen reflector voltage.

With good stability and regulation, and with square wave and saw tooth modulation plus provision for external modulation, Type 809 Klystron Power Supply is equally at home in the laboratory or on the production line.

SPECIFICATIONS

	Type	Voltage (volts)	Current (milliamperes)	Additional Specifications
Output	Beam	Continuously variable 250 to 600	0 to 65	Ripple: < 5mv RMS
	Reflector	Continuously variable 0 to -900	50 μ a max.	Ripple: < 10mv RMS
	Filament	6.3	2 amperes	\pm 3% center tapped
Modulation	Type	Frequency Range (cps)	Nominal Voltage (volts)	Rise Time (microseconds)
	Square Wave	400 to 2000	0 to 90	<10 <10
	Saw Tooth	60 (fixed)	0 to 125	

Price—\$350 f. o. b. Brooklyn, N. Y.

For additional details on PRD 809 Klystron Power Supply, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-24.

Polytechnic Research and Development Co., Inc.

202 Tillary Street • Brooklyn 1, N. Y. • Tel: UL 2-6800

Cable Address: MICROWAVE, NEW YORK



Plastic Moulding Machine

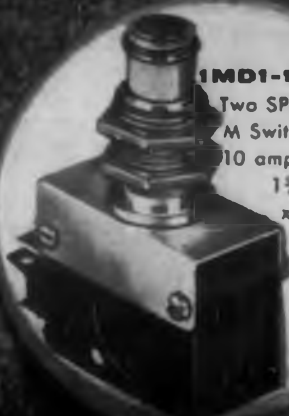
for Encapsulation: This injection moulding machine offers low cost injection moulding of small parts, components, or assemblies, for short to moderate runs. It can handle complex or intricate shapes, and will handle all thermoplastics, including nylon. This machine uses simple V type moulds and is available in air or hydraulic models. Newbury Industries, Dept. ED, Newbury, Ohio

CIRCLE 99 ON READER-SERVICE CARD

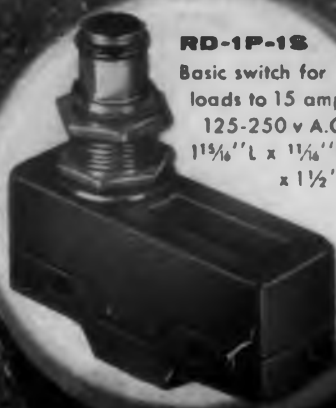
CIRCLE 102 ON READER-SERVICE CARD

ACRO

Push Button Switches



1MD1-1A-A14
Two SPDT Model
M Switches in one.
10 amps. 125 v A.C.
1 3/8" L x 3/8" W
x 2" H



RD-1P-1S
Basic switch for
loads to 15 amps.
125-250 v A.C.
1 1/8" L x 1 1/4" W
x 1 1/2" H



260-0019
Three split contact circuits in
subminiature size. 10 amps.
115 v A.C. 3 1/2" L x 3 3/4" W
x 1 1/4" H



216-0014
Low-cost two pole "open" type.
10 amps. 125 v A.C.
1 3/4" L x 1/2" W x 1 1/8" H



3D05-5P
SPST switch with optional overtravel
and choice of terminals.
12 amps. 125 v A.C.
1 3/4" Dia. x 1 1/2" H

ACRO
Push Button Switches
(rolling spring type) are
available in a wide range
of sizes, shapes and up to
3 circuits. Choice of contacts
permits use in low voltage or milli-amp
circuits. Open or enclosed... with
or without overtravel button
...threaded sleeve for
panel mounting.
Write for complete data!



Robertshaw-Fulton

CONTROLS COMPANY

ACRO DIVISION • Columbus 16, Ohio

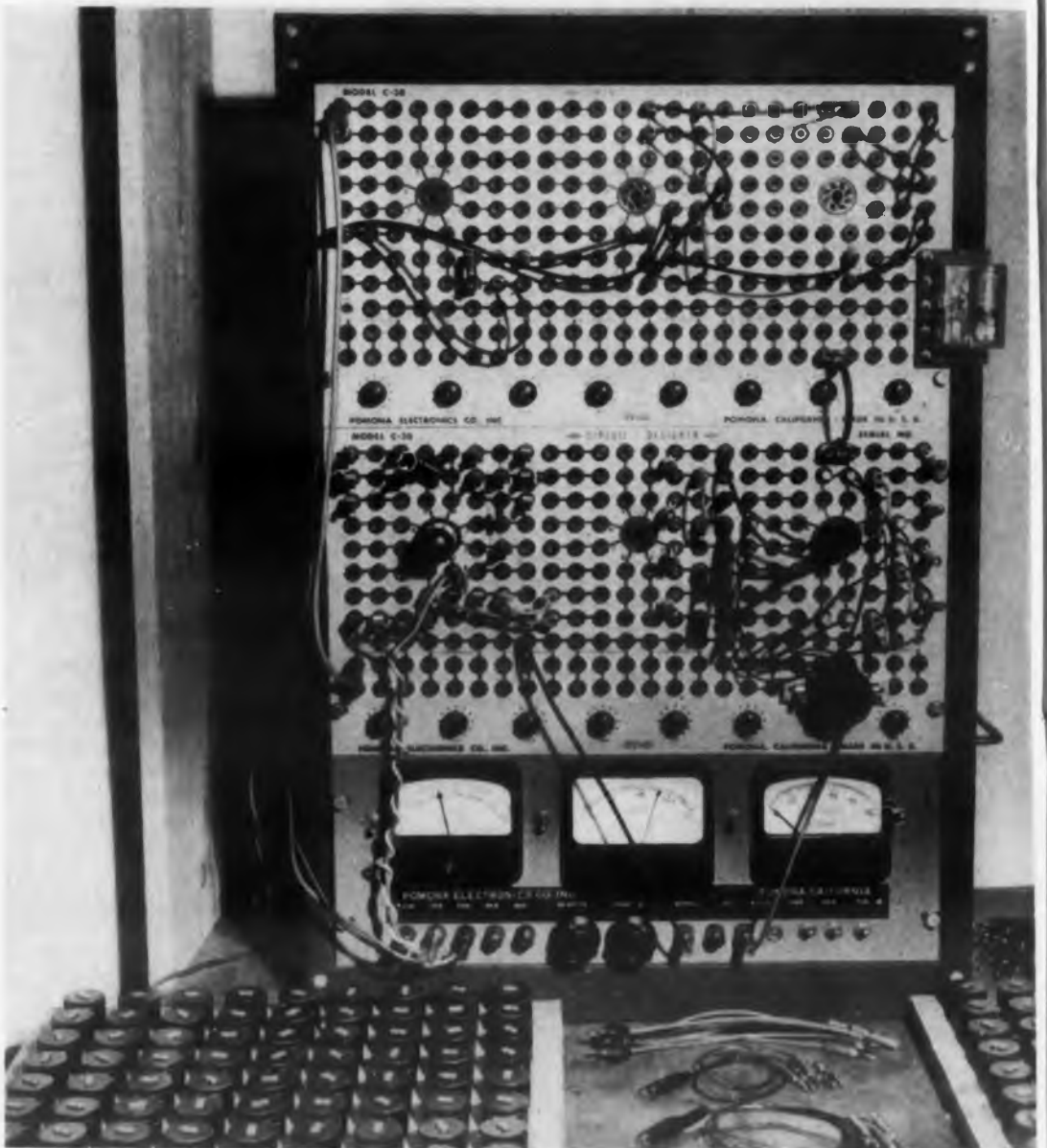
In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto

CIRCLE 107 ON READER-SERVICE CARD



Design for **LOW-COST PRODUCTION**

Versatile Low-Cost Pr



Breadboard set up for production testing of subminiature tube adapters. Useful for short run production testing, the Circuit Designer can rapidly be set up to test a variety of items.

Production Tester

A COMMERCIAL breadboard is used in this production testing technique to provide versatility in checking a variety of short-run items. Simple circuit rearrangements can be made to change from the testing of one kind of unit to another.

Manufactured by Pomona Electronics Co., Inc., Pomona, Calif., the Model C-38 Circuit Designer is shown in the photograph in a seven-pin in-line subminiature tube adapter test setup. Lamps and patch cords are plugged into the board in the appropriate circuit configuration.

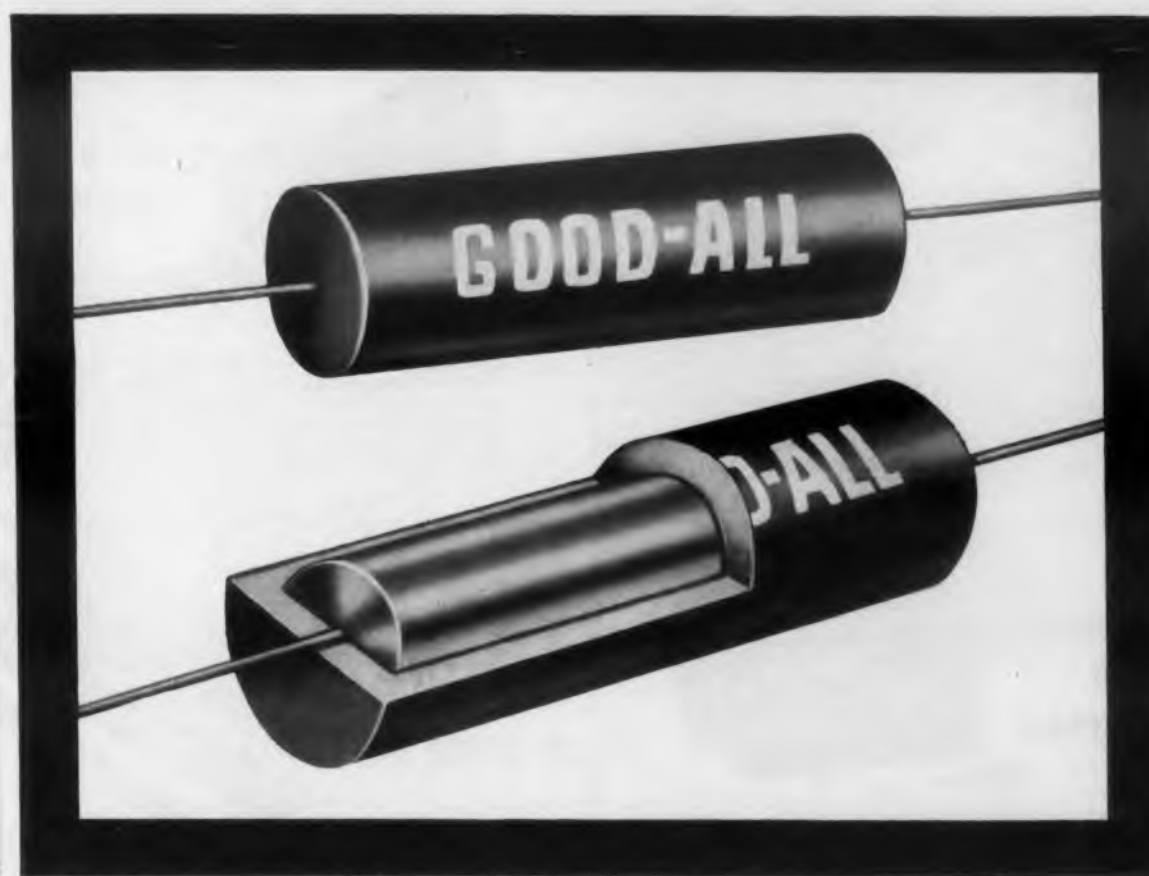
As set up, the tester will check for interelement shorts (two lamps, signifying two elements, light), connection continuity (no light means no continuity), and the correct pin connection (wrong lamp lit means the wrong pin is connected). On each of the seven positions of the rotary switch, the proper lamp lit means the adapter is functioning correctly.

The Circuit Designer is useful at frequencies up to 1 mc. Voltage breakdown of terminals and jacks to the panel is 1800 vdc. Insulation resistance is better than 1500 meg. Using Peco plugs and leads, current carrying capacity is 15 a continuous duty, total connector resistance under 0.01 ohm.

For further information on this breadboard unit, turn to the Readers Service Card and circle 108.

EPON[®] RESIN does it!

Improved GOOD-ALL capacitors have low leakage, high stability—even in extremely humid climates



Here's how:

EPON RESIN is helping to set new standards of excellence in a line of 600 UE capacitors made by Good-All Electric Manufacturing Company, Ogallala, Nebraska.

Good-All reports that Epon resin offers superior moisture resistance . . . far better humidity protection than obtained with

conventional molding materials. These capacitors offer rugged, trouble-free performance because Epon resin assures high dielectric strength, low leakage, great resistance to chemical and corrosive attack, and handsome appearance.

For molding . . . for potting . . . for laminating, sealing and encapsulating . . . Epon resins are pre-

ferred because they offer an almost ideal combination of electrical and physical properties.

Write for complete information on the use of Epon resins in protective enamels, tool and die materials, etched circuit laminates, transformer and motor sealing compounds.

SHELL CHEMICAL CORPORATION

CHEMICAL SALES DIVISION, 380 Madison Avenue, New York 17, New York

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis
IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited • Montreal • Toronto • Vancouver

CIRCLE 109 ON READER-SERVICE CARD





Time Division Multiplexers by ASCOP



TELEMETERING SENSOR SAMPLER

Type A: Sub-miniature 2 pole, 30 contacts per pole switch provides 60 channels in make-before-break operation. A filtered 27.5 volt DC motor rotates the switch at 2.5 RPS providing a sampling rate of 150 samples per second. Solid block construction permits satisfactory operation under random noise vibration of from 36 to 2000 cycles at 18 G's RMS, 160 G's impact for 2 milliseconds and a steady state acceleration of 100 G's.



LOW LEVEL COMMUTATOR

Type AS: The ASCOP Type AS multi-channel rotary sampling switch is designed specifically for airborne telemetering applications where precision high-speed sampling with the utmost reliability is necessary for accurate data. 3 poles 27 channels @ 2.5, 5 or 10 rps, 27.5 VDC governed drive. Proven reliability in 25,000 hours of life testing.

HERMETICALLY SEALED RADAR DISPLAY

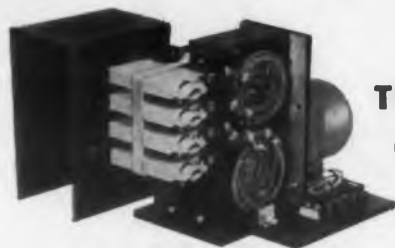


Type AN: This multichannel sampling switch is designed for use in a target designation system for fighter aircraft. The metal on metal hermetically sealed switch housing provides a dust-proof, moisture-proof, explosion proof enclosure to allow the switch to run properly at high altitudes over extreme temperature ranges.

INDUSTRIAL MULTIPLEXER



Type AU: This multipole sampling switch has been designed for the flexibility of application, ease of servicing and long life required for automation and control applications in industry. Speeds from 1 to 1800 RPM, 30 to 250 channels per pole, 1 to 20 poles. Years of service free operation.



THERMOCOUPLE COMMUTATOR

Type Y: Samples 40 independent low level sensors with a noise level below 20 microvolts. By reducing noise and leakage to a minimum, temperature variations smaller than 1°F can be detected when sampling copper-constantan thermocouples.

ASCOP
SWITCH DIVISION

HIGH LEVEL SAMPLING SWITCHES • LOW LEVEL SAMPLING SWITCHES • DISPLAY COMPONENTS • CONTROL EQUIPMENT • COMPARATORS • SENSING SYSTEM ELEMENTS
FUNCTION GENERATORS • TELEMETERING MULTIPLEXERS AND CALIBRATORS • DRIFT COMPENSATORS • THERMOCOUPLE SAMPLERS • MECHANICAL OSCILLATORS

APPLIED SCIENCE CORPORATION OF PRINCETON

P. O. BOX 44, PRINCETON, NEW JERSEY
Plainsboro 3-4141

15551 CABRITO ROAD, VAN NUYS, CALIFORNIA
State 2-7030

1 NORTH ATLANTIC AVENUE, COCOA BEACH, FLORIDA
Cocoa Beach 3900

CIRCLE 110 ON READER-SERVICE CARD



Gas
Thyratron
Equivalent:

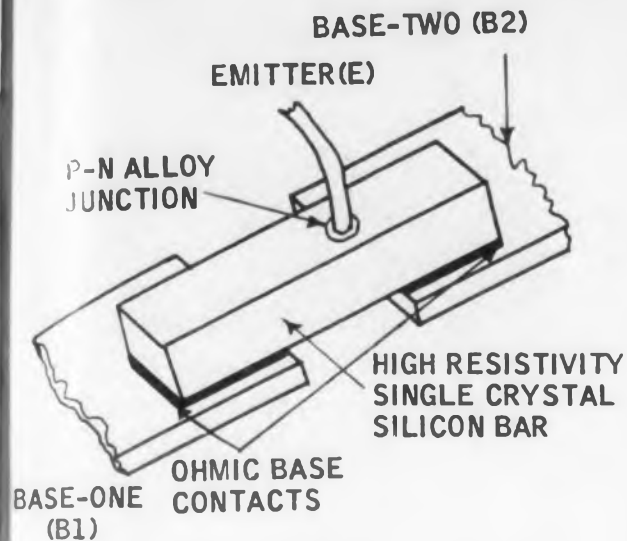
Silicon
Unijunction
Transistor

CIRCUIT simplification and stable negative resistance characteristics are outstanding features of new series of silicon unijunction transistors. Circuitry is such that any of the three terminals can be used as signal input or load output.

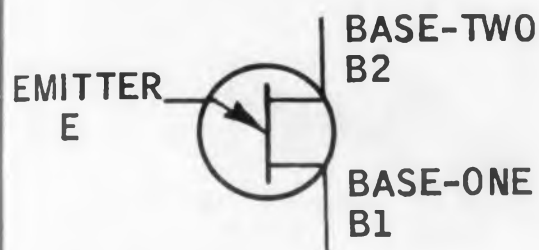
The silicon unijunction transistor is a three-terminal semiconductor device which consists of an N-type silicon bar mounted between two ohmic base contacts, with a P-type emitter near base two. It has stable N-type negative resistance characteristics over a wide temperature range. The transistor can be used for multivibrators, one-shot multivibrators, pulse amplifiers, phase detectors, temperature actuated relays, or as a frequency divider.

Six standard types are available from the General Electric Co., Syracuse, N.Y., having regular JETEC numbers 2N489-2N494. In contrast to the conventional junction transistor, the unijunction transistor exhibits open circuit stable negative resistance characteristics. It is primarily useful in switching and oscillator applications. The unijunction transistor can be operated in a variety of circuit configurations such that any of the three terminals can serve as a signal input or a load output. Its unique ability to sense voltage levels makes it the nearest solid state equivalent to the gas thyatron.

The device operates by conductivity modulation of the silicon between the emitter and base



Construction of silicon unijunction transistor. The Silicon bar is a high resistivity, doped N-type single crystal.



Standard symbol for unijunction transistor.

one when the emitter is forward biased. In the cutoff or standby condition, the emitter and interbase power supplies establish potentials between the base contacts, and at the emitter, such that the emitter is back biased. If the emitter potential is increased sufficiently to overcome this bias, holes (minority carriers) are injected into the silicon bar. These holes are swept toward base one by the internal field in the bar. The increased charge concentration, due to these holes, decreases the resistance and hence decreases the internal voltage drop from the emitter to base one. The emitter current then increases regeneratively until it is limited by the emitter power supply. The effect of this conductivity modulation is modulation of interbase current.

Typical specifications (maximum ratings at 25 C) are: rms power dissipation of 250 mw, rms emitter current of 50 ma., peak emitter current at 150 C of 2 a, emitter reverse voltage of 60 v, and an operating range from -65 to 150 C.

A useful characteristic is the interbase resistance as a function of the bar temperature. The high predictability of the variation with temperature can be utilized to provide effective temperature compensation in many circuit applications. It is also very useful in the design of temperature indicating circuits.

For further information on this product, turn to the Reader's Service Card and circle 416.



If you're after extra quality at no extra cost . . .

TRY BENDIX HIGH GAIN POWER TRANSISTORS

More impressive than anything we can say about Bendix High Gain Power Transistors is the enthusiastic endorsement they are receiving from engineers who have tried them. These design, project, and research and development people report they like Bendix transistors because of their HIGH POWER AND CURRENT GAIN • LOW LEAKAGE • LIFE STABILITY • HIGH BREAKDOWN VOLTAGE • LOW THERMAL RESISTANCE • LINEAR TEMPERATURE VARIATION.

Why this universal acceptance? Because our transistor program is based on the following:

- 1 *Simplified design* that keeps initial cost down and operating dependability up.
- 2 *Extra performance capability* through use of component parts and materials that exceed specification requirements by a sizeable margin.

3 *Improved manufacturing techniques* that help contribute to better transistors at low cost.

- 4 *Uniformly dependable quality . . .* through close quality control that includes comprehensive inspection procedure utilizing Bendix-developed test methods and instruments.

We believe that our many years' experience in designing and producing precision, special-purpose electron tubes has a great deal to do with this extra-high quality and dependability.

We make a wide variety of power transistors. And, because we are in volume production, we can offer immediate delivery on most models. We'll be glad to help you in working

out troublesome circuitry problems, too, if you wish.

It will pay you to get complete details about Bendix transistors. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

BENDIX TRANSISTORS EXCEL AS—

Power Amplifiers	High-Current Switches
Inverters	Power Oscillators
Power Supplies	Motor Controls
Audio Amplifiers	Hi Fi Amplifiers
Voltage Regulators	

West Coast Office: 117 E. Providencia Ave.,
Burbank, Calif.

Export Sales & Service: Bendix International Division,
205 E. 42nd Street, New York 17, N. Y.
Canadian Affiliate: Aviation Electric Ltd.,
P. O. Box 6102, Montreal, Quebec.

Red Bank Division



CIRCLE 111 ON READER-SERVICE CARD

New Products

Transistor Index Provides Rapid Selection



This transistor index facilitates the selection of the optimum transistor for a given application. The method utilizes cards containing pertinent transistor data which have been cross-filed by means of holes and slots at the cards' edge. Selection is rapidly obtained by manually inserting a needle on the basis of desired parameters.

Zeus Engineering Corp., Dept. ED, 635 South Kenmore, Los Angeles 6, Calif.

CIRCLE 112 ON READER-SERVICE CARD

Time Delay Relay Octal Plug Adapter



These time delay relays, called Agastats, are now furnished with octal plugs wired internally to the relay. Two timing adjustments are available, a needle valve and a dial head adjustment. Each is adjustable from 0.1 sec to 15 min. They are available for 6 to 550 v ac operation, or 6 to 230 v dc operation.

Elastic Stop Nut Corp. of America, AGA Div., Dept. ED, Elizabeth, New Jersey.

CIRCLE 113 ON READER-SERVICE CARD

Phase Angle Voltmeter Less than 5 μ V Noise



Phase-sensitive null indication with less than 5 microvolts of noise is possible in control system with the Model 201 BR phase angle voltmeter. The instrument, in portable and rack versions, provides 10 μ v sensitivity as a phase-sensitive null indicator. Harmonic rejection exceeds 55 db, when used with internal filters. Nulling is accomplished at any phase angle. The instrument performs equally well as a meter for direct measurement of magnitude of signal fundamental, phase angle, quadrature and in-phase components.

North Atlantic Industries, Inc., Dept. ED, Westbury, N.Y.

CIRCLE 114 ON READER-SERVICE CARD



Lobing Switch Frequency of 20 to 100 Cps

Development of this lobing switch has been announced for lobing frequencies from 20 to 100 cps. Weighing less than 30 oz, and measuring 3 x 5 in., the lobe has a vswr of less than 1.3 to 1300 mc, while operating with a minimum cross-talk reading of 40 db.

Cado Mfg. Co., Div. of Electromotion Co., Dept. ED, 1646 18th St., Santa Monica, Calif.

CIRCLE 115 ON READER-SERVICE CARD

Radar Duplexer For 35,000 Mc Band



This standard light-weight branch-guide high power duplexer is designed for pulsed radar applications in the 35,000 mc band. The MA-1032 duplexer is designed for use with the 5790 TR tube and ATR-5791 in RG-96/U radar systems. Two models of the MA-1032 are available. The MA-1032A differs from the MA-1032B in that a 36 db waveguide output coupler arm is supplied and provides a reference signal for afc purposes. General characteristics include a vswr of 1.20 max for transmit, and 1.15 max for receive.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 116 ON READER-SERVICE CARD



Test-Point Jacks Miniaturized

Types SKT-13 and SKT-14 test point jacks are approximately one third and one-half, respectively, the 0.637 in. overall length of the popular SKT-10 miniature test-point jack. Teflon insulation provides a voltage rating of 750 rms and flashover of 3000 v at sea level, or 1300 v at 50,000 feet, in a temperature range of -65 to +200 C. The SKT-14 is quickly press-fitted by means of a simple insertion, too.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 117 ON READER-SERVICE CARD

Count-Down Timer Drives 10 Slave Units



Designed for laboratory testing and processing, this count-down timer consists of a master unit, and if desired, from 1 to 10 slave units which may be operated at any distance from the master unit. The timer may be pre-set at 199 minutes or less. By means of \pm signs, time before or after a given event is displayed in seconds.

Industrial Electronics Engineers, Dept. ED, 3973 Lankershim Blvd., N. Hollywood, Calif.

CIRCLE 118 ON READER-SERVICE CARD

Tunable Stalo

L-Band

This L-band local oscillator, tunable over a 10 per cent frequency range, has a high order of short-term stability combined with high power output. Characteristics include a tuning range of 1200-1350 mc, power output of 500 mw or greater, stability of 4-8 cps peak (short-term deviation), size of 9 in. long x 3 in. diam, and weight of 4 lbs.

Pitometer Log Corp., Dept. ED, 237 Lafayette Street, New York 12, N.Y.

CIRCLE 119 ON READER-SERVICE CARD



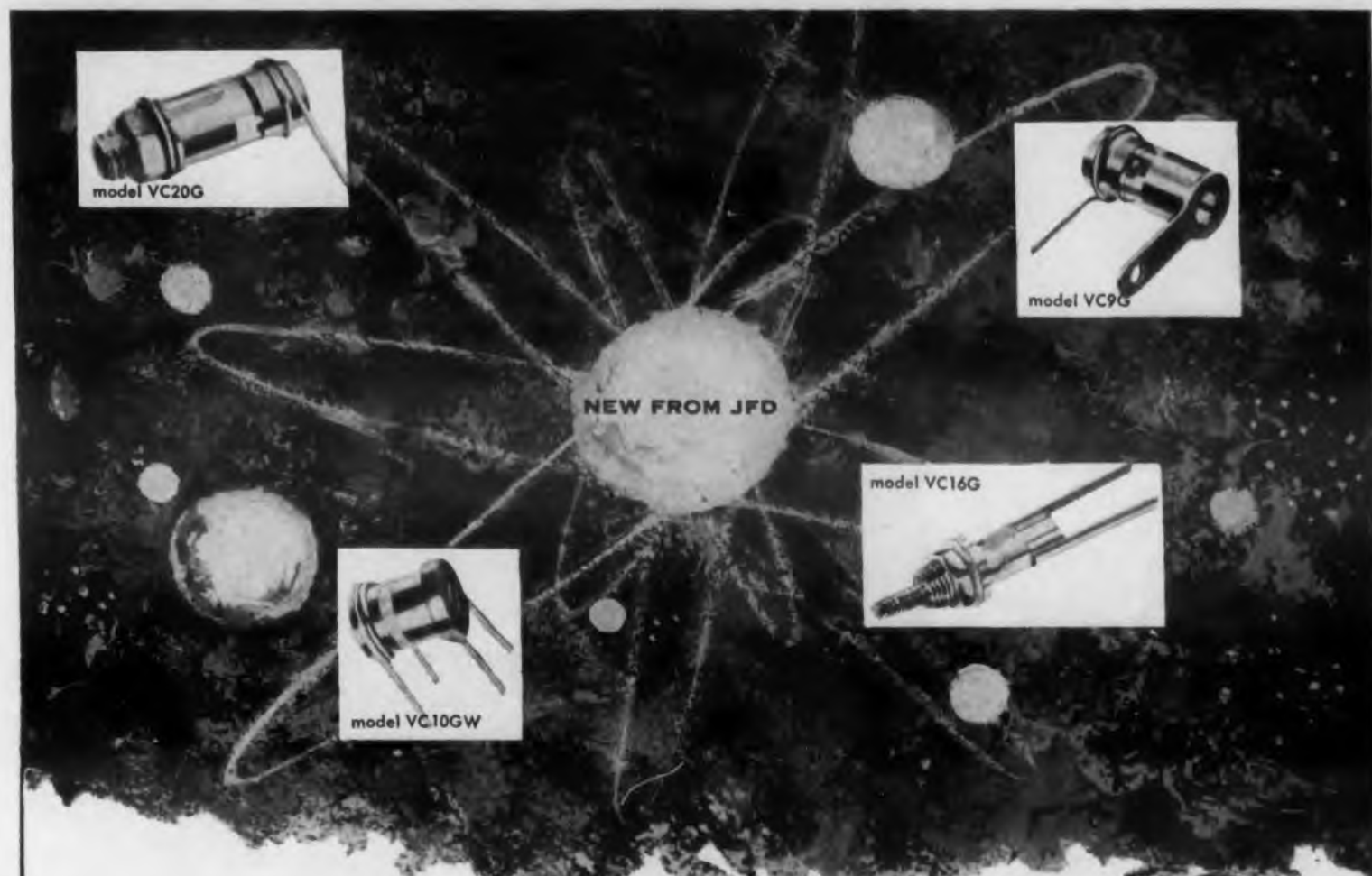
High-Voltage Battery

95 V in 0.14 Cu In.

Called the Dynox 95, this battery measures 1-1/4 in. long by 3/8 in. diam and has a potential of 95 v. It can supply a steady current of 1×10^{-9} amp for 176,000 hr at 70 F with a 10 per cent voltage drop or a flash current of 20 μ amp. Other characteristics include long shelf life and the ability to operate after temperature cycling between -100 and $+170$ F.

Universal Winding Co., Dept. ED, P.O. Box 1605, Providence, R.I.

CIRCLE 120 ON READER-SERVICE CARD



Trimmer Capacitors for Miniaturization and Subminiaturization



WHERE DESIGNS CALL FOR MAXIMUM RANGE IN MINIMUM PHYSICAL SIZE

VC9G Trimmer series (lug & lead type for printed circuits)

Model	Capacitance Range (MMF)	
	Min.	Max.
VC9G	0.8	8.5
VC10G	0.8	4.5
VC31G	0.8	12
VC32G	0.8	18
VC42G	1	21
VC43G	0.8	30

VC9GW Trimmer series (4 wire type for printed wiring boards)

Model	Capacitance Range (MMF)	
	Min.	Max.
VC9GW	0.8	8.5
VC10GW	0.8	4.5
VC31GW	0.8	12
VC32GW	0.8	18
VC42GW	1	21
VC43GW	0.8	30

VC20G Trimmer series (panel type)

Model	Capacitance Range (MMF)	
	Min.	Max.
VC20G	0.8	8.5
VC21G	0.8	4.5
VC22G	0.7	12
VC23G	0.8	18
VC24G	1	30

These new miniature types incorporate the exclusive new JFD telescoping tuning assembly. Both the telescoping piston and self-contained adjustment shaft function as a low inductance coaxial assembly within the dielectric cylinder. This innovation makes possible a highly compact variable trimmer piston capacitor of minimum size for the given capacitance range—up to 50% reduction in overall length compared to previous similar types.

VC16G Split stator series (panel type)

Model	Capacitance Range (MMF) Plate to Plate	
	Min.	Max.
VC16G	0.8	2.5
VC17G	1.1	4.5
VC18G	1.8	7.5
VC80	0.4	1.0
VC81	0.6	1.6
VC82	0.85	2.8
VC83	3.0	6.0

The new JFD Split Stator trimmer series was expressly engineered for critical push pull radio frequency circuits and similar sensitive networks. The extreme stability and low temperature coefficient of the quartz dielectric types recommend these trimmers for applications requiring extreme low-loss operation with maximum tuning resolution. Where maximum range for physical size is needed, you have your choice of the JFD glass dielectric split stator type.

JFD keeps pace with new trimmer capacitors ready to meet new challenges. The result is today's JFD line of 42 Precision trimmers (the industry's largest) to meet your most critical network design and production needs.

Write for Bulletins 201A, 202A, 203A and 204A, for comprehensive electrical data on above JFD trimmers.

PHONE DEWEY 1-1000



ELECTRONICS, INC.

PIONEERS IN ELECTRONICS SINCE 1929

1462 62nd Street, Brooklyn 19, New York

CIRCLE 121 ON READER-SERVICE CARD

New Products

Double Stub Tuner For 1000 to 6000 Mc



One of a line of coaxial components offered by this company is this double stub tuner. Designed for use from 1000 mc to 6000 mc in 7/8 in. coaxial line, it mounts standard UG-45/U and UG-46/U connectors.

Radar Design Corp., Syracuse Custom Div., Dept. ED, 2360 James St., Syracuse, N.Y.

CIRCLE 122 ON READER-SERVICE CARD

Flip-Flop PC Transistorized Plug-In



The first of a series of transistorized, printed circuit digital systems elements has been designated the FF-3. The unit is a flip-flop register which, with associated diode circuits, will gate clock triggers to a maximum of 10 similar flip-flop units without intervening power amplification. It is designed to operate from 0 to 200 kc at temperatures up to 55 C. Input diode gates are included on this card to make the unit a more flexible computer element and simplify the external wiring.

Comptron Corp., Dept. ED, Belmont, Mass.

CIRCLE 123 ON READER-SERVICE CARD

CIRCLE 124 ON READER-SERVICE CARD >



Now—the first 155°C (Class F) magnet wire designed

Another Anaconda first! Anatherm—a new polyester film-coated magnet wire—fully tested for use at “hottest-spot” temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted AIEE 155°C (Class F) rating!

Greater thermal stability—plus excellent

abrasion-resistance characteristics, chemical stability and dielectric strength—makes Anatherm ideally suited for manufacturers seeking maximum performance and reliability from smaller and smaller equipment operating at higher and higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot

HERM

polyester film-coated to meet new AIEE requirements

temperature over the range of 105°C to 155°C.

Available in single and heavy film thickness
in AWG sizes from 15 through 25.



Free Technical Bulletin on Anatherm
Magnet Wire is available. Simply write:
Anaconda Wire & Cable Company,
25 Broadway, New York 4, N. Y. 67878

ASK THE MAN FROM **ANACONDA**[®]
ABOUT **ANATHERM** MAGNET WIRE



Tunable X-band Magnetron 300 Kw Peak Power



The 5780 tunable X-band magnetron is an integral magnet, air-cooled, pulsed type magnetron, which is continuously tunable over a frequency range of 8500 to 9600 mc. The unit is capable of reliable performance at over 300 kw peak power output. The cathode terminal and mounting plate of the tube are designed to fit the standard fixed-frequency 4J50 mounting socket.

Bomac Labs., Dept. ED, Salem Rd.,
Beverly, Mass.

CIRCLE 125 ON READER-SERVICE CARD

Fastener for Subassemblies

Eliminates Loose Parts



This captive fastener, particularly adapted for use on subassemblies consists of a swagged-in-place sleeve a bolt with both a threaded shoulder and shaft, and a small spring. Two turns of the bolt carry it through the threads to become captive within the sleeve. The subassembly may then be tightly fastened to a major assembly by turning the bolt into tapped hole or other mating fasteners. Advantages of the device include elimination of loose fastener parts on the assembly or repair bench and its quick detach features.

Moran Co., Dept. ED, 115 Main St.
El Segundo, Calif.

CIRCLE 126 ON READER-SERVICE CARD

◀ CIRCLE 124 ON READER-SERVICE CARD

Transitron

High Voltage Silicon Rectifiers

VOLTAGE TO 1000 VOLTS · CURRENT TO 1 AMPERE

Features ...

- Reliability at High Temperatures
- High Power Handling Ability
- Small Size
- Hermetically Sealed

Now Transitron offers 1000 and 800 volt silicon rectifiers in two standard packages. The proven stud mounted type can handle current up to 1000ma in temperatures to 125°C. For current ratings to 250ma use the new axial lead type — easy to mount, with no need for insulation. Either type may be used with confidence wherever high forward conductance and low leakage are important . . . for power supplies, magnetic amplifiers, and low frequency switching applications.

High voltage rectifiers are the latest to join Transitron's expanding family of reliable, efficient silicon rectifiers. Transitron offers a large variety of packages and a wide range of voltage and current ratings.

STUD MOUNTED . . . RATINGS AT 125°C CASE

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Average Inverse Current (full load) (ma)
TM104	1000	1000	.5
TM105	1000	400	.5
TM84	800	1000	.5
TM85	800	400	.5

AXIAL LEADS . . . RATINGS AT 100°C AMBIENT

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Average Inverse Current (full load) (ma)
1N561	1000	250	.3
1N560	800	250	.3

Send for Bulletin TE-1351

Transitron

electronic corporation · wakefield, massachusetts



Transistors



Diodes



Regulators



Rectifiers



New Products

Phase Sensitive Detector

Less than 10 Mv Ripple



Model IC-101, phase sensitive detector is a linear demodulator designed for high performance servo systems. Its principal feature is the combination of small time relay and low ripple component of output. This particular model is designed for demodulating 400 cps carrier signals. Input signal range is from 0.025 to 15 volts rms. The output ripple is less than 10 mv and the output impedance is 700 ohms. The unit weighs 15 oz.

Emerson Electric Mfg. Co., Dept. ED, 8100 W. Florissant Ave., St. Louis 21, Mo.

CIRCLE 128 ON READER-SERVICE CARD

Light Duty Switches

Slow Make and Break



Designed primarily for use on ac, these light-duty appliance switches are slow make and slow break switches with silver contacts and a one hole mounting. The use of a slow make and break mechanisms is made possible because of the reduction in arcing on ac. Rated at 3 a 250 v ac, 6 a 125 v ac. Available in spdt models with various operating sequences.

Circle F Mfg. Co., Dept. ED, Trenton, N.J.

CIRCLE 129 ON READER-SERVICE CARD

← CIRCLE 127 ON READER-SERVICE CARD

DC Power Supply Strain Gage Use



Output voltage of the Model SR 200 transistorized strain gage power supply is continuously variable from 5 to 12 v at currents to 200 ma. Regulation is ± 0.1 per cent for line fluctuations from 95 to 135 v. Transients within this range will not cause overshoot or ringing nor affect rated regulation. The unit may be used on frequencies from 50 to 400 cps. Six units can be mounted in one 19-in. rack panel 3-1/2 in. high.

Video Instruments Co., Inc., Dept. ED, 2340 Sawtelle Blvd., Los Angeles 64, Calif.

CIRCLE 130 ON READER-SERVICE CARD

Locknut With Nylon-Insert



This line of nylon insert locknuts have a die-cast zinc alloy hex nut body and a molded nylon compression collar for the locking element. The nylon locking element maintains a constant grip on the screw threads, dampens vibration, seals out moisture, and resists loosening. The nylon collar tends to return to its original shape permitting reuse many times without appreciable reduction in locking torque. The locking effect exists at any point along a mating screw.

Gries Reproducer Corp., Dept. ED, 400 Beechwood Ave., New Rochelle, N.Y.

CIRCLE 131 ON READER-SERVICE CARD



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

Enamel resists moisture and chemicals

No harmful effects from moisture or active chemicals . . . that's what was learned from actual laboratory tests on General Electric resistors. After 360 hours of actual contact with water, salt water, solvents, and alkalis, the special vitreous-enamel coating on General Electric resistors was still giving air-tight protection to the delicate wire windings!

General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. They will hold their rated tolerance even under extreme temperature conditions (+700° F to -70° F). Their terminals will hold up to 21 pounds of right-angle pull—and a special terminal is available to hold up to 34 pounds of pull!

Like more information? Ask your General Electric salesman for a free set of sample resistors and conduct

your own tests. And send today for the new 36-page catalog containing complete information on ratings, dimensions and ordering directions.

Industry Control Department, Roanoke, Virginia.

SEND TODAY FOR FREE RESISTOR CATALOG

Section D784-7
General Electric Co., Schenectady, N.Y.

Please send a copy of GEA-6592, G-E Resistor Catalog.

Name _____

Company _____

Address _____

City _____ State _____

Progress Is Our Most Important Product

GENERAL  ELECTRIC

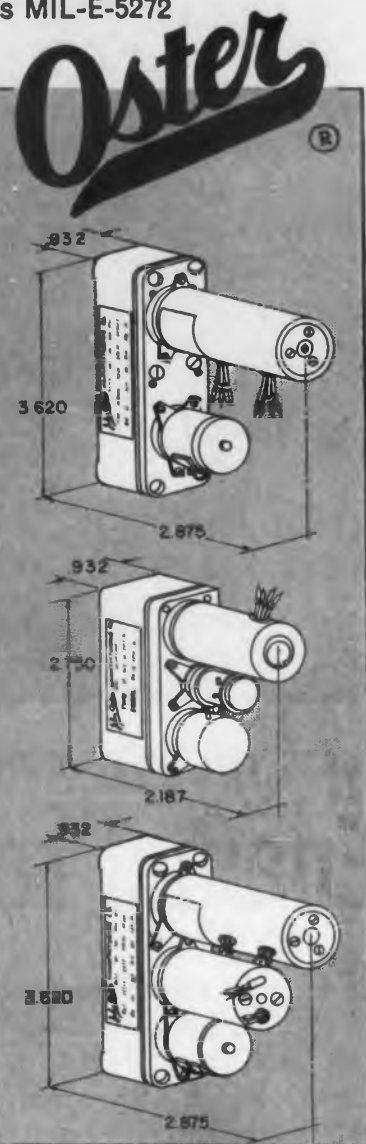
CIRCLE 132 ON READER-SERVICE CARD

MODULIZED SERVO SYSTEMS

QUICKLY INTERCHANGEABLE... EASILY SERVICED

- Miniaturized
- Lightweight
- Simple, fast installation
- Meets MIL-E-5272
- Can be hermetically sealed with dimensional changes

OSTER TYPE	SB-9805-01	SB-9805-02	SB-9805-03	SB-9805-11
Motor				
Fixed Phase Voltage	26v	115v	115v	26v
Control Phase Voltage	26v	115v	115v	26v
Frequency	400	400	400	400
Max. Power @ Stall	6	5	5	6
No Load Speed	10,500	10,000	10,000	10,500
Generator				
Excitation Voltage Phase 1	26v			26v
Output Phase 2	0.3v/1000 RPM 100,000 ohm load			0.3v/1000 RPM 100,000 ohm load
Null	.012v			.012v
Wobble Voltage (Power Excitation)	.007v			.007v
Linearity	3.5 watts Max. 0.5% to 4000 RPM			3.5 watts Max. 0.5% to 4000 RPM
Potentiometer				
Mechanical Rotation	360°	360°	360°	360°
Resistance	1000 ohms	50,000 ohms	50,000 ohms	1000 ohms
Accuracy of Total Resistance	±5%	±5%	±5%	±5%
Electrical Angle	350°	350°	350°	350°
Servo Block Unit				
Ambient Temperature	-55°C to 72°C	-55°C to 72°C	-55°C to 72°C	-55°C to 72°C
Altitude	-1000 feet to 55,000 feet	-1000 feet to 55,000 feet	-1000 feet to 55,000 feet	-1000 feet to 55,000 feet
Life	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.
Gear Train				
Ratio	1000 : 1	336 : 1	167 : 1	10,000 : 1
Dust Enclosed per	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A
Backlash	Anti-Backlash gear on pot.	1°	1°	Anti-Backlash gear on pot.
Synchro				
Input Voltage—Stator	11.8v			
Output Voltage—Rotor	10.6v			
Clutch Brake				
Input Voltage		100v dc	100v dc	
Input Power		2.0 watts Max.	2.0 watts Max.	
Operate Time—Energize		5 milliseconds	5 milliseconds	
Operate Time—De-energize		20 milliseconds	20 milliseconds	



Offered as illustrated with identical or different combinations of:

- gear ratios
- clutch
- brake
- clutch-brake
- servo
- synchro
- motor-tach
- potentiometer

Write for further information TODAY, enclosing details of your requirement.

Other products include motor-gear-trains, synchros, AC drive motors, DC motors, servo mechanism assemblies, motor tachs, servo torque units, reference and tachometer generators, actuators, motor driven blower and fan assemblies and fast response resolvers.



Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Zelazo, Director of Research, in confidence.

CIRCLE 133 ON READER-SERVICE CARD

New Products

DC Millivoltmeter
1 Mv Full Scale



Model 216A consists of a direct reading dc millivoltmeter and dc amplifier. The instrument features a zero center indication with ± 1 mv dc full scale, and a zero point so stable that no zeroing control is provided. Maximum amplifier gain is 1000, input impedance 2 meg, and full scale sensitivities range from 1 mv to 10 v dc in 9 overlapping ranges. Designed for rack-mounting, panel dimensions are 19 by 8 in. with a depth of 8 in.

Industrial Control Co., Dept. ED, 805 Albin Avenue, Lindenhurst, L.I., N.Y.

CIRCLE 134 ON READER-SERVICE CARD

Linear Amplifier
200 μ V Input Sensitivity



The Model 672A A1D linear amplifier, built to ORNL Specification Q1326, is designed to amplify pulses of low signal level from counters to usable levels that can function in counting systems such as scalers and pulse height analyzers. Input sensitivity is from 200 μ v to 1 mv. Gain ranges from 12,000 to 2000 according to bandwidth switch position. Output at high amplifier output is 5 v into 1000 ohms; at low amplifier output, 5 v into 150 ohms. Linearity of the instrument is better than 1 per cent from 9 to 90 v output. Stability is better than 1 per cent after 24-hr warm-up.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 135 ON READER-SERVICE CARD

For Dependable Components — SANDERS ASSOCIATES, Inc.



10 μ A Magnetic Relay

Withstands Severe Shock

Model 2B1 magnetic contact relay is rated at 10 μ A and contains within its sealed case a reset mechanism. Once contacts close, they cannot be separated except by this reset. Capable of withstanding 500 g and severe vibration, the relay consists of a D'Arsonval movement which closes circuit when the input signal reaches a preset limit. Model 281 is available with either single or double limits, and can pass either ac or dc.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 136 ON READER-SERVICE CARD

High-Frequency Scope Identical X-Y Deflection



Type 536 oscilloscope has identical horizontal and vertical deflection characteristics with the same type of preamplifier plugged into both channels. It converts to a general-purpose instrument when the Type 53/54T time-base generator is plugged into the horizontal amplifier. Horizontal and vertical characteristics include: differential inputs, dc-to-10 mc pass bands, 0.035 sec reset time, nine calibrated deflection factors from 0.05 v per div to 20 v per div with vernier controls for adjusting sensitivity between steps, less than one deg relative phase shift to well beyond 10 mc, adjustable phase balance up to 20 mc, five divisions of deflection at 20 mc without overdriving input amplifiers.

Teltronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

CIRCLE 137 ON READER-SERVICE CARD

FLEXIBLE PRINTED CIRCUITS — A new concept in wiring and harnessing, Sanders flexible printed circuitry eliminates wiring errors and reduces assembly costs. Flexible circuits and cables can be made in single- or multi-layer form for use in electronic systems, computer harnesses, switchboards and appliances. Multi-layer construction takes up to 65% less space than conventional wiring, and in some applications has reduced weight by 75%.



"MINICUBE" BLOWER — A compact, high-velocity blower and motor, in a 1" cube. Designed for use in guided missiles, aircraft, etc. Rugged construction assures reliable performance over a wide range of environmental conditions. Wt: 1 oz.; Input: 400 cps, 4 watts; Output 3 C.F.M.

PHASE COMPARATOR — A versatile, full-wave bridge comparator for use as a modulator, demodulator, or switch. Frequency Response: 0-5000 cps; Max. Reference Voltage: 120V. rms; Max. Output Voltages = \pm 50V. DC; Dynamic Range = 46 db. Hermetically sealed.



TRI-PLATE MICROWAVE COMPONENTS — The bulk and weight of conventional microwave systems can be substantially reduced with Sanders TRI-PLATE components, including variable attenuators, balanced mixers, hybrid rings, directional couplers, low pass filters, power dividers and receiver front ends. Low cost, low leakage and high reliability. Complete systems can be designed for specific application.

RATE GYROSCOPE — A precision subminiature device for converting rate into an A.C. signal. Meets requirements of sensitive control and stabilizing systems for aircraft and missiles. Features include: • Lifelong Hermetic Sealing • Excellent Resolution • High Sensitivity • Small Size: 2 9/16" long x 15/16" Diameter • Light Weight: 3-1/2 oz.



CIRCLE 138 ON READER-SERVICE CARD

"Consistently dependable". That's the national reputation established by the electronic, electro-mechanical and hydraulic components engineered and produced by Sanders Associates.

Sanders offers a complete engineering service — including departments for systems engineering, research aerodynamics, modular electronics, microwave engineering, electro-mechanics and hydraulics, commercial development, special purpose tubes, and complete type test facilities. Extensive manufacturing facilities available.



For complete information write Dept. K

SANDERS ASSOCIATES
INCORPORATED

DEPT. K., NASHUA 11, NEW HAMPSHIRE

West Coast Field Office: 1608 West Centinela Boulevard
Inglewood, California

UNION



NEW SERVO-RATIO MULTIMETER

Combines all the functions of an AC-DC voltmeter, ohmmeter and AC-DC ratiometer in one compact portable unit

Here is a new, highly accurate test instrument designed to make life easier for those who work with computers and other electronic and electrical devices. It measures AC-DC ratios, absolute AC-DC voltages and resistance. You can also measure the gain of operational amplifiers using the 0° phase output provided.

The Servo-Ratio Multimeter computes voltage ratios by dividing the voltage to be measured by the reference voltage obtained from the computer. It is a high-impedance instrument and utilizes a motor-driven, position-type servo mechanism. Average time to obtain a reading is three seconds. Simplification and reliability are obtained through the use of printed circuits.

The front panel contains a four-digit illuminated drum counter for readout, phase or polarity indicating lights, function switch, ON-OFF

switch, range switch, 0° phase ratio selector, input terminals and 0° phase output terminals.

The Servo-Ratio Multimeter is compact and easy to handle. It has an aluminum case and weighs only 10 pounds. The instrument can be operated in a horizontal or vertical position and has a unique carrying handle that serves as a tilt-stand when the unit is used horizontally. Write for Product Description 2005.

SPECIFICATIONS

Power Consumption: 50 Watts, 110 Volts, 60 cps.
Reference Voltage: DC or 60 cps AC; ± 10 Volts to ± 100 Volts across 8.7K Ohms Load.

Functions	Range
Ratio, AC	0.001 to 1.000 $\pm 0.1\%$ in 1 range
Ratio, DC	0.001 to 1.000 $\pm 0.1\%$ in 1 range
60 cps AC Voltage	1 Volt to 1000 Volts full scale $\pm 1.0\%$ in 4 ranges
DC Voltage	1 Volt to 1000 Volts full scale $\pm 1.0\%$ in 4 ranges
Ohms	10K Ohms to 10 Megohms full scale $\pm 1.0\%$ in 4 ranges
Gain	0.01 to 1000 in 4 ranges



PORTABLE AND COMPACT—Weighs only 10 pounds. Size: 7 $\frac{1}{8}$ " x 5 $\frac{1}{2}$ " x 11-13/16".

SIMPLIFIES TESTING—Eliminates need for many other instruments. Has digital readout counter.



 **UNION SWITCH & SIGNAL**
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

New Products

Wire Harness Clamp Teflon Cushioned



This line of wedge-locked wire harness clamps is cushioned with Teflon for its insulation properties, low coefficient of friction, and wide chemical and temperature resistance. A feature of the clamp is the avoidance of metal to metal contact. Upon closing, the wedge affords a double-sealing action at the tips, preventing wires from being forced out or pinched.

TA Mfg. Corp., Dept. ED, 4607 Alhambra St., Los Angeles 39, Calif.

CIRCLE 140 ON READER-SERVICE CARD

Pendulous Accelerometer 0.1 Per Cent Accuracy to 50 G



The output signal of this accelerometer is proportional to the amount of force required by a torque generator to restore the system to a balanced position. Developed to meet the need for an accurate accelerometer over the range from ± 0.1 to ± 50 g full scale this unit has an overall accuracy of 0.1 per cent with a threshold of 1×10^{-6} of full scale.

Physical Measurements Corp., Dept. ED, 1650 19th St., Santa Monica, Calif.

CIRCLE 141 ON READER-SERVICE CARD

CIRCLE 139 ON READER-SERVICE CARD

Potentiometers

Short Case Length



Available in 5 and 10-turn types, Types HA-100 and HA-105 feature short case lengths of 15/16 in. on the 5-turn model and 1-1/4 in. on the 10-turn. Standard linearity is ± 0.5 percent. Type HA-100 is rated at 2 w with standard resistance values from 2500 to 75,000 ohms. Type HA-105 is rated at 1.5 w and has resistance values from 1000 to 25,000 ohms.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 142 ON READER-SERVICE CARD

Rotary Switch

Adjustable Stop



For flexibility in circuitry where the exact number of switch positions might be changed at a later date, this rotary switch is equipped with an adjustable stop. The unit has a maximum of either 24 positions with 15 deg spacing or 32 positions with 11-1/4 deg. One, two, three, and four pole units are available in this design. The switch features large silver alloy contacts and slip rings, silver alloy rotor blades, and gold flashed turret-type terminals for ease of soldering.

The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 143 ON READER-SERVICE CARD



MINIATURIZED SEALED RELAYS



COLD...but still in control!

Chances are you've never seen a sealed relay frozen in an ice-cube tray. But, this illustration does dramatize the ability of General Electric miniaturized sealed relays to operate in similar low-temperature regions. G-E sealed relays can function normally in solid ice!

The fact is, the best of laboratory equipment is used to check the continuous operation of all G-E hermetically sealed relays at ambient temperatures of *minus 65 C*—about 65 degrees colder than the ice cubes in this tray! Inherent temperature-resistant characteristics qual-

ify *all* General Electric sealed relays for use on any job where cold is a serious environmental problem.

Extreme low-temperature operation is just one of the many "plus" features—such as high-shock resistance, high-vibration resistance, high-temperature operation, and rugged construction—you get with *all* Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric relays are proving their reliability on a variety of military and industrial electronics jobs.

What's more, you get all of General

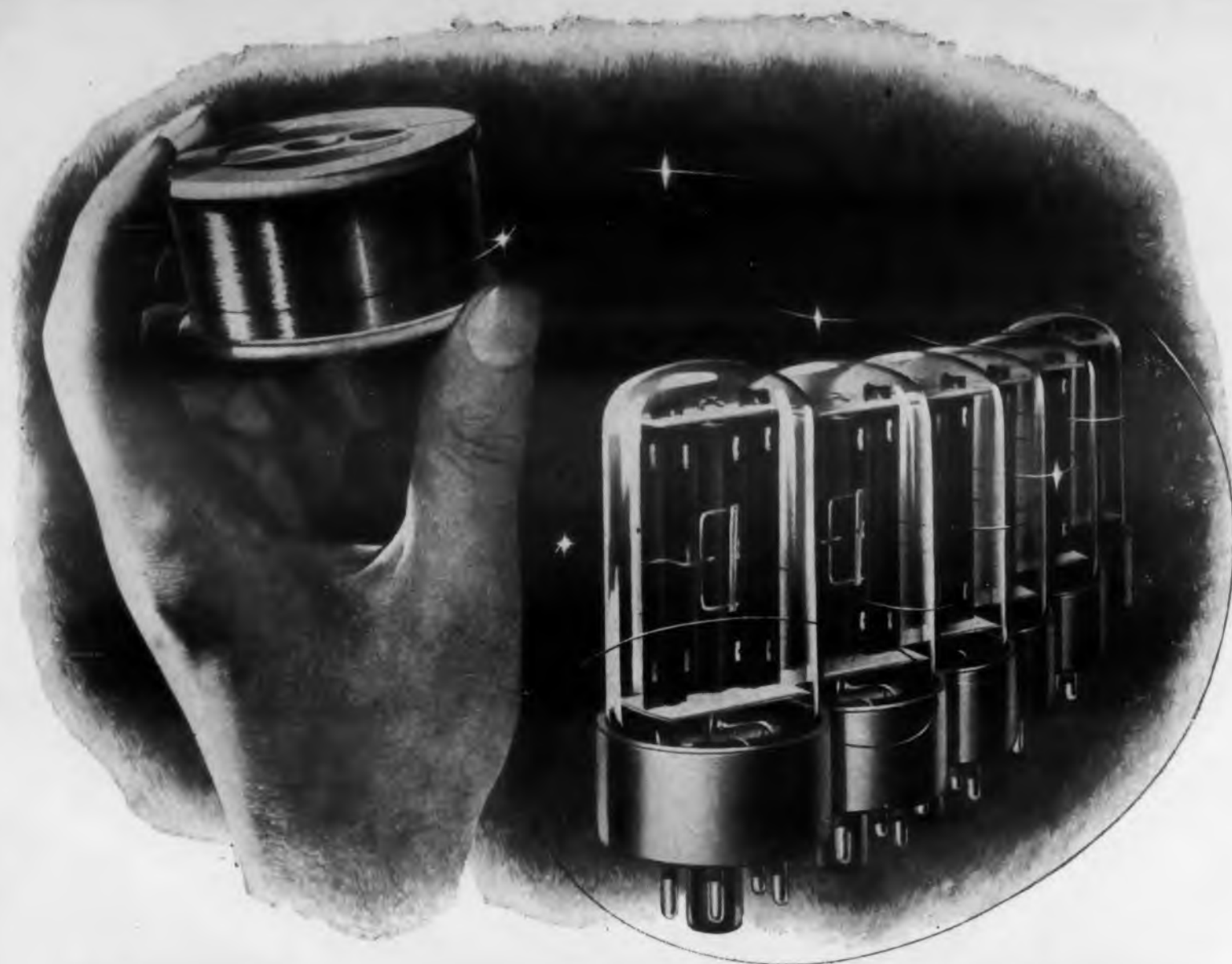
Electric's complete line of standard-listed relays on only *3-week shipment from receipt of order*—plus—immediate service on samples and prototypes.

For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Sect. 792-8, Schenectady 5, N. Y., for complete relay data. *Specialty Control Dept., Waynesboro, Virginia.*

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 144 ON READER-SERVICE CARD



TUNGSTEN and MOLYBDENUM from SYLVANIA

... where metallurgy and electronics
speak the same language

BECAUSE WE'RE OUR OWN TOUGHEST CUSTOMERS, we've acquired the habit of producing tungsten and molybdenum to exacting mechanical and electrical standards.

In the production of tungsten and molybdenum wire, for instance, Sylvania's over-all background in the production of electronic equipment has enabled the Tungsten and Chemical Division to develop wire that is electronically right for today's high reliability standards and physically right for today's faster winding techniques. By exercising complete, integrated control—from metal powder through finished rod and wire—Sylvania can meet your speci-

fications for tungsten and molybdenum with the characteristics you need in sizes down to 0.10 mg (0.0002 inch).

Whether you need tungsten and molybdenum rod or wire, chances are you'll find a standard Sylvania grade that meets your requirements exactly. If not, Sylvania's fully integrated production methods can go to work to produce the characteristics you want—and to control them every step of the way.

For a complete discussion of your tungsten and molybdenum requirements, contact your Sylvania sales engineer. Write today for technical data and specifications.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

SYLVANIA ELECTRIC PRODUCTS INC.
Tungsten and Chemical Division
Towanda, Pennsylvania



SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • METALS & CHEMICALS

CIRCLE 145 ON READER-SERVICE CARD

New Products



Servo Motor
High Torque for Low
Power Input

The size 8 No. 008E2A servo motor offers 0.25 oz-in. torque for a 3.4-w input. A high acceleration of 44,000 radians per sec² and a temperature rating of 150 C are also featured.

Norden-Ketay Corp., Dept. ED, Commerce Rd., Stamford, Conn.

CIRCLE 146 ON READER-SERVICE CARD

PC Digital Cards

Transistorized

Offered for purchase are eight transistorized printed circuit digital element cards which may be plugged into a special mounting chassis capable of holding a total of 15 cards. Six additional logic cards are also available. In combination the two sets form logical interconnections for any type of computer or control system. The cards may be ordered singly or as a set. Special systems to fit customer needs can be designed.

Comptron Corp., Dept. ED, Belmont, Mass.

CIRCLE 147 ON READER-SERVICE CARD

Digital Line Plotter

Line Graphs from Punched Cards



This digital line plotting system converts digital point data to an accurate continuous line graphic plot. The system accepts data from a digital computer by means of punched cards or punched tape and converts the quantities into a series of line segments, which form a continuous line when inked on coordinate paper.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 148 ON READER-SERVICE CARD

Time Code Generator 16 Bit Binary Code



Designed for airborne instrumentation, this time code generator consists of transistor-driven magnetic cores, and supplies a 16-bit, 24-hr binary code in hours, minutes, and seconds. Signals generated by the equipment are suitable for recording timing marks or time codes on tape and film. The binary code readout is once per sec at a 100 pps rate. Time can be read directly to 0.01 sec and interpolated to 0.001 sec. In addition to binary code, continuous pulse trains of 100 pps, 10 pps, 5 pps, and 1 pps are produced.

Electronic Engineering Co. of Calif., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 149 ON READER-SERVICE CARD

Power Transistor Tester Permits Rapid Evaluation



An instrument for rapid testing of npn and pnp power transistors at their normal operating power, the Model 102 power transistor tester is designed both for laboratory use and for routine inspection. It measures collector current for zero emitter current at base-collector voltages from 0 to 75 v; large signal current gain at collector currents up to 2 a, collector voltages from 0 to 28 v, and base currents up to 50 ma; small signal current gain in the grounded emitter connection at any chosen operating point; and collector-base breakdown voltage. Measurements may be made over a wide range of operating conditions, with minimum heating, and the controls are arranged for quick, simple setup.

Strand Engineering Co., Dept. ED, 1354 N. Main St., Ann Arbor, Mich.

CIRCLE 150 ON READER-SERVICE CARD

Concerned with microwave test equipment?

Only NARDA offers you these exclusive features!

TURRET ATTENUATORS

Only Narda offers you a UHF-only attenuator. This represents a considerable savings in cost for applications in this frequency range. Each of three models offers the Designer or Development Engineer 12 steps of attenuation from d.c. to 1,500 mc with a VSWR of 1.25. Designed for bench use or mounting into test equipment packages.



One unit can give a maximum of 30 db attenuation; two units can be used in series to provide a wide range of control in small steps.

Model 705—0, 3, 6, 9, 12, 15, 20, 25, 30 db
Model 706—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20 db
Model 707—0, 3, 6, 9, 12, 15, 18, 21 INF db

ALL MODELS... \$275 each

COAXIAL DIRECTIONAL COUPLERS



10, 20 and 30 DB... 225 to 4,000 mc.

Only Narda offers coaxial directional couplers in 10 and 30 db values, as well as 20 db. In addition, all models offer such advantages as these:

1. Flat Coupling—values with 1 db of nominal over a full octave frequency range, with calibration provided to ± 0.2 db accuracy.
2. Machined from solid blocks of aluminum—hence, more rugged.
3. Directivity exceeding 20 db.
4. Frequency Ranges: 225-460, 460-950, 950-2000, 2000-4000 mc.

Write for complete specifications.

\$100 to \$225



S to X BAND FREQUENCY METER

Narda offers the only single instrument covering this complete band of frequencies—2,350 to 10,500 mc. In addition, no combination of other meters can cover these frequencies at a comparable price!

An easy to read nomograph type calibration chart, mounted in the lid, converts digital counter readings to frequency in megacycles—to the rated accuracy of 0.2%. No calculations or interpolations are needed.

The unit is completely self contained, with built-in detector and indicating meter. A sensitivity control allows use with strong signals; for signals below 5 mw., the external meter jack may be connected to an amplifier or oscilloscope.

Model 802B... \$785

UHF FREQUENCY METER DETECTORS... Direct Reading

The only direct reading frequency meter detectors available for the UHF range—and they're from Narda, of course! Absorption type meters, with 0.2 db insertion loss, each includes a resonant cavity, coaxial switch, crystal detector, current meter, sensitivity control and type N terminals.

SPECIFICATIONS

Frequency (mc)	Accuracy	Loaded Q	VSWR	Sensitivity for full scale deflection	NARDA Model	Price
200-500	0.5 mc	500	1.15	0.2 mw	804	\$375
500-1500	1 mc	700	1.15	0.2 mw	805	375
1500-2400	2 mc	500	1.25	0.5 mw	806	375

Complete Coaxial and Waveguide Instrumentation for Microwaves and UHF — Including:

DIRECTIONAL COUPLERS	TUNERS	ATTENUATORS
TERMINATIONS	ECHO BOXES	STANDARD REFLECTIONS
FREQUENCY METERS	SLOTTED LINES	SOLOMETERS
HORNS	BENDS	THERMISTORS

MAIL COUPON TODAY FOR
FREE CATALOG AND NAME OF
NEAREST REPRESENTATIVE


The Narda Microwave Corporation
160 Herricks Road
Mineola, N. Y.
Dept. ED-2

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

 the narda
microwave corporation

160 HERRICKS ROAD, MINEOLA, N. Y. • PIONEER 6-4650

CIRCLE 151 ON READER-SERVICE CARD

TYPE	RES. RANGE		POWER RATING		LENGTH
	MIN.	MAX.			
R	10 Ω	1,000 K	7-115 W	DC	1½" to 12"
H	10 Ω	1,000 K	7-140 W	AC	1½" to 12"
HP	10 Ω	500 K	17-150 W	DC	3" to 12"

Why Corning High-Power, High-Frequency Resistors meet your most exacting circuit requirements

You'll find Corning High-Power and High-Frequency Resistors designed for stable, long-life service—even under the most difficult operating conditions.

With Corning Resistors you get the highest resistance range for a given physical size compared to wire-wound resistors.

Their thin-film construction makes them inherently non-inductive. The noise level of these resistors is so low it's difficult to measure. The resistive film is a metallic oxide, fused to the PYREX® glass core at red heat to form a permanent bond. This special glass insures highest core resistivity even at elevated temperatures, great resistance to chemical attack and to mechanical and thermal shock.

These Corning Resistors are remarkably stable regardless of mois-

ture and humidity.

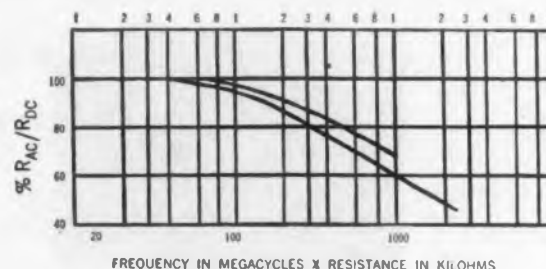
They meet all characteristics of MIL-R11804B.

The chart in the next column gives you a quick idea of their exceptional frequency characteristics.

The ranges and ratings shown in the illustration are for our standard lines, but we can design and build resistors to match your own requirements for all usable frequencies. We have made specials with ratings up to 150 kw. and we can go higher.

Within the standard range of these resistors, we can give you wide variations in mounting hardware. You can get hardware for vertical or horizontal mountings and mountings to absorb mechanical shock and severe vibration. Ferrule-type terminals are available for use with standard fuse clips.

For more complete details, write for catalog sheets.



Keep your file up-to-date with data on these other electronic components made by Corning in addition to the Types R*, H, and HP Resistors: Low Power, Types N, S*, and WC-5; Capacitors: Fixed Glass*, Transmitting, Canned High-Capacitance. Subminiature Tab-Lead, Special Combination. Direct Traverse* and Midget-Rotary* Trimmers. Metallized: Glass Inductances; Attenuator Plates; Fotoform Glass; Electrolytic Level Switches.

*Distributed by Erie Resistor Corporation

New Products



Program Timer
Settings Changed Quickly

Model PT-157 will independently control the sequence and timing of several related operations of a process. The unit is designed to permit rapid and accurate change of the time settings controlling each operation. The unit as shown controls six different operations. More operations may be controlled by adding one switching comparator for each additional on-and-off operation. Versatility and ease of maintenance is provided through the unitized plug-in construction of the major component parts. Time cycles up to five minutes are available, with accurate settings for each time control made against a calibrated meter.

Electronic Processes Corp. of Calif., Dept. ED, 2190 Folsom St., San Francisco 10, Calif.

CIRCLE 153 ON READER-SERVICE CARD

Intercom Switch
Heavy Duty 1-Oz Unit



This aircraft microphone intercommunication switch, No. 426501, is a momentary 2-position, split-pole switch with a snap feel. Operation is fail safe, direct, and fully dependable even under adverse environmental conditions, overloads, and high altitudes. No relays are needed. The unit measures 1-1/16 in. from the bottom of the terminals to the mounting face, and 1-7/8 in. overall. Weight is 1 oz. Capacity: 10 amp resistive at 30 v dc for 25000 cps. Contacts are heavy-duty silver alloy, and the case material is glass-reinforced thermosetting plastic. Snap action make and break is completely independent of the hand.

Mason Electric Corp., Dept. ED, Los Angeles, Calif.

CIRCLE 154 ON READER-SERVICE CARD

Corning means research in Glass



CORNING GLASS WORKS, 97-11 Crystal Street, Corning, N. Y.

Electronic Components Sales Department

CIRCLE 152 ON READER-SERVICE CARD

Instrument-Transit Case Has Humidity Indicator



This combination instrument-transit case has been developed to withstand extremes of environment conforming to MIL-T-945A. The case, an all aluminum unit designed around the standard 7 x 19 in. instrument panel, consists of a water-tight outer box and lid which embodies a recessed carrying handle, humidity indicator and pressure relief valves. A removable inner case, to which the panel is affixed, is shock-mounted and sealed by a neoprene gasket. The case is available in a variety of depths from 3 to 10 in. in box or lid, or from 6 to 20 in. total depth openings as desired.

Zero Mfg. Co., Sales Div., Dept. ED, 1121 Chestnut St., Burbank, Calif.

CIRCLE 155 ON READER-SERVICE CARD

Low Null Voltage Transducer Has Plug-In Assembly



This transducer was developed to replace a precision potentiometer as a feed-back element in the circuitry of a hydraulic servo missile van control system. Featuring a plug-in terminal for lead wires, the unit has a low null voltage of 20 mv rms (max), making possible a sensitivity of 0.49 mv per 0.001 in. displacement per volt input at 2500 cps. Input is 12-1/2 v, 2500 cps single ended and grounded; impedance is greater than 2500 ohms. Output is 6.1 v per 1 in. displacement at rated excitation; impedance is less than 700 ohms. Range is ± 0.63 in. Phase angle is less than 20 deg between ± 0.01 in. and ± 0.05 in., less than 16 deg between ± 0.05 in. and ± 0.5 in.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

CIRCLE 156 ON READER-SERVICE CARD

Monitor radiated signal frequencies 100 times faster!

with accuracy of ± 1 cps...over
range of 0.54-30.5 megacycles



Beckman/Berkeley Model 7700 Microsensitive Frequency Measuring System

Featuring

Exclusive direct digital readout—7-place numerical display for speed, accuracy and convenience.

Broad utility—measures AM, ICW, frequency shift keyed and multiplexed signals.

Extreme sensitivity—detects and measures signals of 1 microvolt strength.

Advanced engineering design—exceeds FCC specifications, is suitable for compliance with Part 15, FCC Rules and Regulations.

Wide range and bandwidth selectivity—30 1-mc frequency bands; bandwidth of 100 cps-6 kc for interference rejection.

Price: \$3500.00 F. O. B. factory

DESIGN AND PERFORMANCE SUPERIORITY

Comprising a unique combination of a quality communications receiver and a high-speed electronic counter, Beckman/Berkeley Model 7700 provides 100,000 times the customary counter sensitivity, and 100 times the frequency measurement speed of other equipment. Its extreme sensitivity and accuracy permit quick, precise measurement of virtually all types of radiated signals in the 0.54 to 30.5 megacycle range, with maximum error of 1 in 10^7 .

Simple and easy to use, the Model 7700 makes possible the measurement and monitoring of broadcast or other frequencies by non-technical personnel with a minimum of training. The system consists of three basic units: a broad range communications receiver, a translator with oscilloscope comparator, and a time-gated electronic counter. An audio system is incorporated for aural monitoring where desired.

Complete technical information on the Beckman/Berkeley Model 7700 Microsensitive Frequency Measuring System is available on request. Write to Dept. D-11.

Beckman

Berkeley Division

2200 Wright Avenue, Richmond 3, California

a division of Beckman Instruments, Inc.

148

CIRCLE 157 ON READER-SERVICE CARD



TRANSISTORIZED POWER SUPPLIES



New DC to DC Power Supplies for Mobile and Airborne Applications

Eicor power supply units are now available with input voltages from 6 to 30 VDC and output ranges from 50 to 500 VDC in the following sizes—

Part No.	Power (Watts)	Weight	Size
DC-25	25	½ lb.	2 x 2 x 3
DC-50	50	¾ lb.	2 x 2½ x 3
DC-100	100	1 lb.	2½ x 3 x 3½
DC-200	200	1¼ lb.	2½ x 3 x 4

Write today for more detailed information

Inverters • Converters • Power Supplies • Generators
DC Motors • Dynamotors • Transistorized Power Supplies



EICOR

4233 WEST NORTH AVE., CHICAGO 39

Another F. L. Jacobs Division

CIRCLE 158 ON READER-SERVICE CARD

New Products

Alternate Pulse Relay Selects Alternate Circuits

The PC single-coil latching relay selects alternate circuits or alternate circuit modes on successive impulses. The relay employs an armature driven rocker type actuator to transfer one, two, three or four dpdt snap switches. Contacts are rated at 10 amp, 115 ac resistive. The relay can be operated from ac or dc sources and provides positive transfer on a single 30 msec impulse.

Potter & Brumfield, Inc., Dept. ED, Princeton, N.J.

CIRCLE 159 ON READER-SERVICE CARD



Sweep Generators Audio to 200 Mc

This line of variable rate sweep generators have output frequencies from audio to 200 mc, and sweep rate continuously variable from 1 cpm to 60 cps. Model VR-1, shown, has an output frequency range of 15 kc to 15 mc, with center frequency adjustable over the range and sweep width variable from 50 kc to 15 mc. Other features include 1 v peak to peak output into 50 ohms, zero base line, horizontal drive voltage, toggle switch attenuator and crystal markers.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 160 ON READER-SERVICE CARD

10 Db Omnidirectional Antenna For 450-470 Mc Band

Type 212 Omnidirectional Antenna has a measured gain of 10 db across the entire band of 450 to 470 mc. Suppressor elements incorporate the features of a single feed point, while maintaining high aperture efficiency and eliminating wasted radiation. The lightweight antenna is enclosed in a fiberglass radome for unfavorable weather conditions. Supplied in three sections, over-all length is 23 ft.

Andrew Corp., Dept. ED, 363 East 75th St., Chicago 19, Ill.

CIRCLE 161 ON READER-SERVICE CARD

Smaller
and
Smaller
and
Smallest



At left: typical Mallory Mercury Battery; 250 milli-ampere-hours. Right: STNT capacitor; ratings 40 mfd., 3 VDC to 4 mfd., 50 VDC. Both components actual size.

Save space—without sacrificing performance—in your subminiature circuits, by designing around Mallory components. Those pictured here are typical of Mallory designs that lead the parade of miniaturization.

Mercury batteries, pioneered and perfected by Mallory, give high energy output in tiny physical size . . . provide constant discharge ideal for use with transistors.

New Type STNT Subminiature Tantalum Capacitors pictured are hardly bigger than a bulge on the leadwires; only 0.145" in diameter, 0.250" long . . . ratings from 40 mfd., 3 volts to 4 mfd., 50 volts. Four other Mallory subminiature electrolytic models include types suitable for miniaturized electronic product, commercial or military.

Write to Mallory today for technical data, and for engineering consultation on your specific subminiature circuit application.

P. R. MALLORY & CO. INC.
Indianapolis 6, Indiana

P. R. MALLORY & CO. INC.
MALLORY

CIRCLE 162 ON READER-SERVICE CARD

PROTECT YOUR COMPONENTS

ELIMINATE HOT SPOTS

VENTILATED RELAY RACK CABINETS

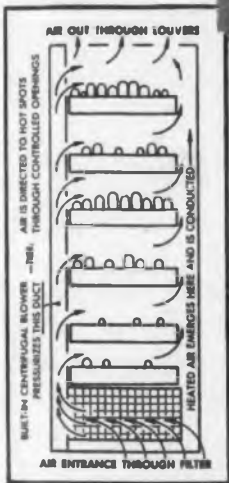
MIL Spec Quality
Complete Package
Modular Construction

Fully Controlled
built-in
Cross-ventilation
System

Cool Exactly
Where Needed

Cool Heat Load
of 2-3 KW Input

Proven in
4 Years' Operation
in Government
Laboratories



MODEL
FC1-24V-68 1/4 H

Dolly Optional

STANDARD UNITS:
19" to 24" Panels
18" to 36" Deep

Matching Consoles
Available

OTHERS TO YOUR
SPECIFICATIONS

NOTE:
Adjustable air-flow
pattern to your
exact needs is
effected by snap-in
closures—no
'chimney' effect

- Available in cabinets or consoles —with 12-gauge or 3/16" steel frame
- Adjustable interior rails afford ready mounting for chassis slides
- Front and rear doors with glass panels or cutouts
- Paint finish to customer requirements

Write for Complete Data: Series FC/ED

ONE SOURCE...

for VENTILATED RELAY RACK
CABINETS, CONTROL CONSOLES,
BLOWERS, CHASSIS, 'CHASSIS-
TRAK'®, RELATED COMPONENTS

ORchard 4-3510

WESTERN DEVICES, INC.

600 W. FLORENCE AVE., INGLEWOOD, CAL.

*For Inquiries on 'Chassis-Trak', East of Rockies:
Chassis-Trak Corp., Indianapolis

CIRCLE 163 ON READER-SERVICE CARD



Carbon Film Resistors

5/64-In. Diameter

Both of these resistors have a range from 5 ohms to 100 K and are rated at 1/10 w at 70 C. Type C-1H is sealed in a ceramic case for protection against humidity, and meets requirements of MIL-R-10509B, characteristic B. It measures 9/32 in. long by 5/32 in. diam. Type C1 is resin coated, and is not damaged when potted in epoxy resins. Meets characteristic X and measures 15/64 in. long by 5/64 in. diam.

Mepco, Inc., Dept. ED, Morristown, N.J.

CIRCLE 164 ON READER-SERVICE CARD



Counter Electric Reset

Model YE counter counts up to 1500 counts per min, and can be instantly reset to zero either electrically or by a push button. They are offered in panel mounting or base mounting and with either type of reset. Figures are 3/16 in. high.

Durant Mfg. Co., Dept. ED, Milwaukee 1, Wis.

CIRCLE 165 ON READER-SERVICE CARD



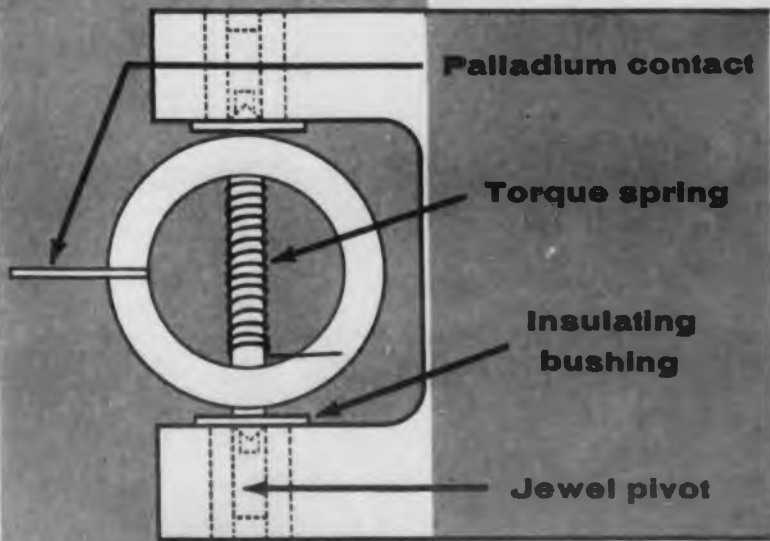
Frequency Measuring System

Reads from 0.54 to
30.5 Mc

Known as the Model 7700 frequency measuring system, this unit makes quick accurate measurements of virtually all types of radiated signals in the 0.54 to 30.5 mc range. Tuning the receiver to the desired frequency renders a direct digital reading on the counting unit. Accurate to 1 part in 10⁷, the instrument picks up signals as weak as 1 μv, and can measure am, icw, frequency shift keyed and multiplexed signals.

Beckman/Berkeley Div., Beckman Instruments Inc., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

CIRCLE 166 ON READER-SERVICE CARD



**2,000
CYCLE
VIBRATION!**

Now a totally different mechanical design overcomes limitations of conventional precision potentiometers. The heart of the matter is "dynamic balance" — (1) arm dynamically balanced on shaft (2) contact assembly dynamically balanced on arm. Advantages: low mass, low inertia, long life, .1% linearity, exceptional stability under extremes of vibration, shock and acceleration.

another result of

dynamic balance[®]*

Incidentally, we know these are hot pots mechanically ... but they're also hot for temperature, too. Power derates to zero at 165°C standard — 225°C special.

"Dynamic Balance" . . . it's the very essence of the "1000 series" of linear and functional precision potentiometers. It means a new dimension in circuitry design! Proved operationally successful in a variety of military equipments even under severe environmental conditions, "1000 series" pots open the way to reliable electronic systems withstanding higher frequencies and temperatures.

Get complete engineering data on the "1000 series" line. Write today.

electronic components division

Chicago Aerial Industries, Inc.

10265 Franklin Avenue • Franklin Park, Illinois
CIRCLE 167 ON READER-SERVICE CARD

* Patent Pending



ABOVE: Dr. J. P. Hagen, Director of Project Vanguard, uses a model to illustrate the manner in which the satellite will be carried into its orbit. The earth satellite program is sponsored by the National Academy of Science and the National Science Foundation. Project Vanguard is the name assigned to the Department of Defense portion of the program. (Official United States Navy Photograph)

RIGHT: A cutaway view of a Minitrack mobile trailer housing equipment for tracking the satellite. Eight Minitrack receiver input strips are used in the receiver cabinet. Each strip receives a signal from one of eight antennas.

GL-6299 low-noise G-E triode is designer's choice for Minitrack System of tracking Earth Satellite



ACTUAL SIZE

When the satellite is launched in 1958 as part of a United States program for the International Geophysical Year, it will be followed in its orbit by a unique tracking system. This system, known as Minitrack, was designed by the U.S. Naval Research Laboratory and built by Bendix Radio Division, Bendix Aviation Corp. The system uses General Electric tube Type GL-6299 in a major role.

The tracking system consists of a transmitter in the satellite, and a series of receiving stations strategically placed to intercept the radio signals.

This transmitter will have an output power of as low as 10 milliwatts. Consequently, a circuit had to be designed to provide low-noise amplification of the signals. The low-noise G-E GL-6299 was picked for the R-F stage in this circuit because of its ability to provide sufficient power gain to prevent any significant contribution by the mixer stage to the over-all receiver output noise.

The designers of the Minitrack System took advantage of the tube's exceptionally low noise figure of only 2.5 db

at 108 mc. Additional advantages realized were receiver input strips with greater inherent stability, freedom from neutralizing requirements, and ease of alignment procedure.

Ratings of the GL-6299, based on performance results of the triode as a Class A₁ grounded-grid, coaxial-type RF amplifier with a 10-megacycle bandwidth include: a noise figure of 4 to 5 db at 400 mc.; 8 db at 1200 mc.; and less than 13.5 db at 3000 mc.; a gain of 17 db at 1200 mc. and 10 db at 3000 mc. Successful completion of extended life tests is responsible for the recent increase in tube warranty from 500 to 1000 hours, with no increase in price.

For detailed literature or application assistance, contact your regional power tube representative, or write to *Power Tube Department, General Electric Co., Schenectady, N. Y.*

Progress Is Our Most Important Product

GENERAL  ELECTRIC

9545-9481-4

CIRCLE 168 ON READER-SERVICE CARD

New Products

Polystyrene Capacitor Long Term Stability



Stability of this polystyrene dielectric capacitor is within ± 0.1 per cent of original value after repeated temperature cycling and under long term load. No capacity drift trend can be detected. Processing and quality control techniques enable elimination of all border-line components.

Diamond Electronics Corp., Dept. ED, 64 White St., New York 13, N.Y.

CIRCLE 169 ON READER-SERVICE CARD

Push Button Switch Solderless Wiring



Series 34 silent-action model for solderless wiring is a non-snap, normally open, momentary contact spst switch designed with taper pins. Three female receptacles are provided with a built-in short between two of them to accommodate in and out wiring with A-MP no. 53 taper pins.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., La Grange, Ill.

CIRCLE 170 ON READER-SERVICE CARD

Teflon Wire Improved Color Coding

Improved color coding of Teflon tape insulated wire can be obtained due to new techniques developed for spirally tape-wrapping two different colored stripes on white or colored backgrounds. The two different colored stripes of two different widths are so applied that the background

color is always visible between them. Background spacing is so controlled to give maximum legibility. Spiral stripes are wrapped as an integral part of the insulation, are clear and vivid in color, non-fading, permanent.

Wirecraft Products, Inc., Dept. ED,
10 Lake St., West Brookfield, Mass.

CIRCLE 171 ON READER-SERVICE CARD

Selenium Diode for Computer Use



The SP1M4H867 has such uses as replacement for a germanium diode in which considerable difficulty can be encountered because of random surges of pulses. Specification include 50 ma intermittent duty, 5 ma continuous duty, and a peak inverse voltage of 150 v.

Bradley Laboratories, Inc., Dept. ED, New Haven, Conn.

CIRCLE 172 ON READER-SERVICE CARD

Oscilloscope Small Size, General Purpose



Called the Handiscope, Model 466 oscilloscope has a 5-in. screen, filter-type graticule, and universal-fit bezel. The scope measures 8 x 12-1/4 x 16-1/2 in., and specifications indicate that it is suitable for industrial maintenance and production testing, as well as for general communications equipment.

Simpson Electric Co., Dept. ED,
5201 West Kinzie St., Chicago 44, Ill.

CIRCLE 173 ON READER-SERVICE CARD

CIRCLE 174 ON READER-SERVICE CARD ➤

STEMCO THER

for electronic and

Features to fit your
and electro
production-line Sta
just part of

Because
of bimetal ther
unusual
various te
pro
ranges



TYPE A
Semi-enclosed

Insulated, electrically independent bimetal disc gives fast response and quick, snap action control. Operation from -10 to 400 F or higher on special order. Various mountings and terminals. Rated from 4 to 13 amps at 115 volts AC, depending on service conditions. 4 amps at 230 volts AC and 2.8 volts DC. Bulletin 3000.



TYPE A
Hermetically sealed

Electrically identical to semi-enclosed Type A. Temperature from -10 to 300 F. Various enclosures and mountings, including brackets, available for appliance, electronic, apparatus applications. Bulletin 3000.



TYPE C
Semi-enclosed

Small, positive-acting. Electrically independent bimetal strip for operation from -10 to 300 F. Rated at approximately 3 amps, depending on application. Terminals and mountings to customer specifications. Bulletin 3000.

STEMCO THERMOSTATS

Avionic applications

Special requirements for avionic applications—from standard, Stemco thermostats. That's the Stemco story.

Stevens makes the widest range of thermostats in the industry, we offer an abundance of basic design types . . . terminal arrangements and mounting provisions . . . different temperature and performance characteristics. In addition, Stemco thermostats feature small cubage, light weight and proven reliability—at a production price.

So get the Stemco story first. Write, call or wire now while your product is in the planning stage.

*Refer to Guide 400 EO for U.L. and C.S.A. approved ratings.

STEVENS manufacturing company, inc.

Lexington and Mansfield, Ohio

AA-6306

STEMCO

THERMOSTATS



TYPE C

Hermetically sealed

Electrically identical to semi-enclosed Type C, but sealed in crystal case. Also supplied as double thermostat "alarm" type. Terminal terminals or wire leads. Bulletin 5030.



TYPE M

Semi-enclosed

Electrically independent bimetal disc type. Min. compliance and electronic applications. Terminal terminals. Rating: 115 volts AC, 4 amps; 230 volts AC, 2 amps; 240 volts DC. Minimum size Type Terminal. Bulletin 5030.




TYPE M

Hermetically sealed

Electrically independent bimetal disc type. Min. compliance and electronic applications. Terminal terminals. Rating: 115 volts AC, 4 amps; 230 volts AC, 2 amps; 240 volts DC. Minimum size Type Terminal. Bulletin 5030.

Four Bulletins ON FANSTEEL TANTALUM CAPACITORS

Fansteel TANTALUM CAPACITORS
Bulletin A.100-1
Supersedes Bulletin A.100



WRITE FOR BULLETINS INDICATED

- Bulletin A.104 "77" Series — For General Use
- Bulletin A.111 "80" Series — High Temperature
- Bulletin A.112 "57A" Series — Duty Tantalum
- Bulletin A.113 "82" Series — Vibration Resistant

FANSTEEL METALLURGICAL CORPORATION
RECTIFIER-CAPACITOR DIVISION
NORTH CHICAGO, ILLINOIS, U.S.A.



FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U. S. A.

CIRCLE 175 ON READER-SERVICE CARD

New Products

Wire Stripping Tool Positive Lock



The Strip-It features a positive lock that can easily be adjusted to strip any size from No. 10 through No. 20 single or stranded wire instantly. The positive lock will not slip. Made of high quality steel, hardened, tempered, and plated, the tool will snip wire as well as strip it.

Hunter Tool Co., Dept. ED, Box 564, Whittier, Calif.

CIRCLE 176 ON READER-SERVICE CARD

Timing Device Measures 1-1/2 In. Sq

Weighing 6 oz, this 1-1/2 in. sq timer has potential use for repeat cycle, time delay, and sequence control. Designed for 115 v 400 cps, 115 v 60 cps and 28 v dc. It is internally shock-mounted to meet applicable military specifications and operates in a temperature range of -55 to +125 C and at altitudes of 60,000 ft.

The Advanced Products Co., Dept. ED, 59 Broadway, North Haven, Conn.

CIRCLE 177 ON READER-SERVICE CARD

DC Power Supply 0-150 V at 2 Amp



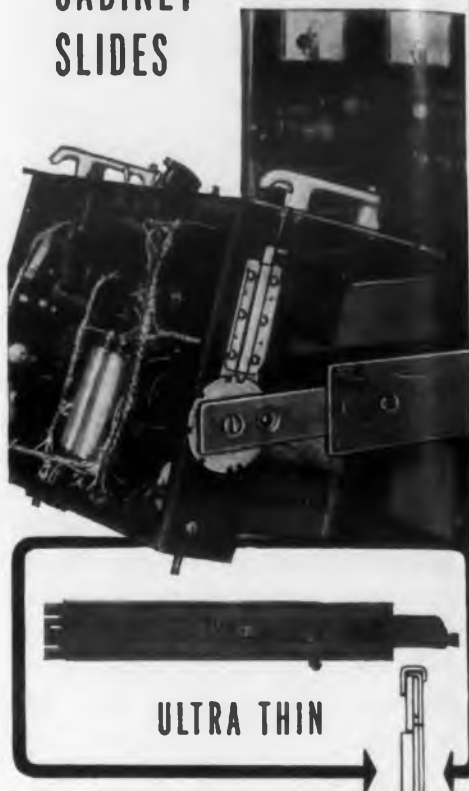
Model TM25 is a tubeless laboratory type regulated dc power supply with a continuous duty rating of 0 to 150 at 2 amp. Voltage regulation is ± 1 per cent and ripple is less than 0.03 per cent of the average dc at maximum output. The unit occupies 8-3/4 in. of panel height. Depth behind the panel is 9 in.

Opad Electric Co., Dept. ED, 69 Murray St., New York 7, N.Y.

CIRCLE 178 ON READER-SERVICE CARD

SPECIFY Chassis-Trak

ROLLER BEARING
CABINET
SLIDES



New Chassis-Trak roller bearing slides make your electronic equipment more accessible . . . faster and easier to service. Chassis Trak's ultra thin design, wider bearing rollers support up to 175 lbs. with chassis extended. Rollers assure permanent, smooth slide operation.

PLUS:

- Ultra thin slide design (.350") for maximum use of cabinet interior
- Permanent, dust-repellent, dry lubricant finish
- High corrosion resistance
- Easy installation
- 8 stock lengths, standard width
- Push button emergency chassis removal

WRITE: DEPT. 2ED

Chassis-Trak, Inc.

525 S. WEBSTER AVENUE
INDIANAPOLIS 19, IND.

CIRCLE 179 ON READER-SERVICE CARD

HIGHEST
INSULATION RESISTANCE
and
CAPACITANCE STABILITY

LOWEST
POWER FACTOR
and
STORAGE



fci
POLYSTYRENE
and **TEFLON**
CAPACITORS



OPERATING TEMPERATURE

up to 85°C. for Polystyrene
up to 200°C. for Teflon

TEMPERATURE COEFFICIENT

-100 ppm/°C. for Polystyrene
-50 ppm/°C. for Teflon

AVAILABLE IN

hermetically sealed glass tubes
with metal end caps
style CPO6 metal shells
with glass-seal buttons
bathtub cases with low-loss
glass terminals
style CP70 metal cans with
low-loss glass terminals

SPECIAL UNITS

including multi-section blocks
available on special order or
made to specifications



fci

Detailed data
available
from

film capacitors, inc.

3400 Park Ave., New York 56, N. Y. • CYpress 2-5180

CIRCLE 180 ON READER-SERVICE CARD

Line Impedance Stabilization
As Required by Mil Specs



Series FSR-700 lines impedance stabilization networks are designed specifically for use in laboratories making r-f interference measurements in accordance with Air Force Spec MIL-I-6181B and Navy Spec MIL-I-16910A which require a network to be inserted in each power supply lead and electrical load lead during measurements of radiated and conducted noise.

The FSR-700 series networks are available for 50, 100, 200 and 500 amp service. Maximum voltage ratings for all units are 115 v at 800 cps, 230 v at 400 cps, 440v at 60 cps and 600 v for dc operation. Mating AN connectors are furnished with all units as required.

Filtron Company, Inc., Dept. ED, Flushing, N.Y.

CIRCLE 181 ON READER-SERVICE CARD

Inverter

Drives Sync Motors from 12 V DC



The PV-2 inverter is a transistorized power supply designed to operate 50 or 60 cps synchronous motors from a 12 v dc source. The inverter is tuning fork controlled and capable of operating motors rated up to 140 v-amp input. Output waveform is a modified square wave ideally suited for driving synchronous motors. The output voltage frequency is accurate to 0.01 per cent and stable to 0.01 per cent. Magnitude, adjustable in steps, yields 115 v rms of the 50 or 60 cps component of the modified square wave output.

Mandrel Industrial Instruments, Div. of Mandrel Industries, Dept. ED, 5134 Glenmont Dr., Houston, Tex.

CIRCLE 182 ON READER-SERVICE CARD

New Bulletin



FANSTEEL

SILICON

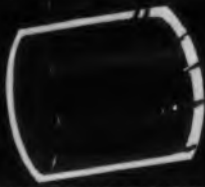
RECTIFIERS

- Write today for your **FREE Copy**

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U. S. A.



CIRCLE 183 ON READER-SERVICE CARD



a new measure



in Celco



precision

TOROIDAL COMPONENTS



Whether it's a complex 10 winding magnetic amplifier or a simple choke . . . at Celco each toroid is precision-made. New core materials are used in Toroidal magnetic amplifiers, reactors and transformers to achieve maximum performance.

At Celco, the proper matching of cores, winding, handling, impregnation, encapsulation and electrical history of the final assembly is carefully controlled to maintain the original design characteristics.

Our years of design, development, and production know-how are available for application to your specific TOROIDAL problems.

* For immediate attention,
call DAVIS 7-1123
— or write today.

Celco

Constantine Engineering Laboratories Co.
MAHWAH, NEW JERSEY

CIRCLE 184 ON READER-SERVICE CARD

New Products



Vibration Pickup For Low Amplitude Studies

The Type 4-120 vibration pickup can be used in all high-frequency, low amplitude vibration studies. The instrument is capable of continuous operation from -65 to $+500$ F. It has a frequency range of 40 to 2000 cps with linearity of ± 4 per cent of reading (for constant frequency) over the entire range. Insensitive to transverse vibration, the Type 4-120 will produce a signal directly proportional to the velocity as low as the recording equipment will measure. Maximum acceleration without damage is 50 g. The unit measures 1-1/4 x 2-3/4 in. and weighs less than 5 oz.

Consolidated Electrodynamics Corp., Dept. ED, 300 North Sierra Madre Villa, Pasadena, Calif.

CIRCLE 185 ON READER-SERVICE CARD

Trimming Potentiometer High Stability



Designated the G-720 Series, this trimming potentiometer is epoxy sealed around the cover and around the leads where they emerge from the case, and a silicone O-ring is placed behind the leadscrew opening. Glass mandrels are used for the coil windings to give the dimensional stability needed to hold close tolerances. End resistance is zero, hence the whole range is usable. The unit is adjustable throughout 32 turns by a screwdriver in a slotted shaft. Because the wiper is supported on all sides, settings are stable under extreme vibration.

Aero Electronics Corp., Dept ED, Gardena, Calif.

CIRCLE 186 ON READER-SERVICE CARD

This
low cost
**HARD
BRIGHT
GOLD**
has practically
no free cyanide

Technic HG Gold provides all the attributes you have needed in hard bright gold. In particular, cyanide is less than 1/10 oz. per gallon . . . cost is less than 10¢ per troy oz. over regular 24 kt. gold. In addition —

TECHNIC HG GOLD QUALITIES:

Bright smooth-grained deposits; super hardness (130-150 DPH); low stress, less porosity than usual bright gold; high karat (23+).

TECHNIC HG GOLD ADVANTAGES:

Wide operating range (60° to 95°F), no cooling or heating required; no organic brighteners; high efficiency (requires less gold to meet most specifications).

Only Technic HG Gold fills all your requirements. We invite you to apply any practical performance tests — prove to yourself that it meets every standard of what hard bright gold should be.



Send for Brochure: **TECHNIC HG GOLD**

TECHNIC, INC.
39 Snow Street,
Providence, R. I.
JACKSON 1-4200
Chicago Office—7001
North Clark Street

THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

CIRCLE 187 ON READER-SERVICE CARD



*Half the Size...
Uses 100 the Power*

**OF THE SMALLEST
CONVENTIONAL VCO
NOW AVAILABLE**

Uses subminiature tubes and printed circuitry. 9 telemetering oscillators, operational mixer and self-contained power supply, all packaged within .09 cubic feet. Available on all standard RDB channels . . . with either 7.5% or 15% deviation. Uses Cannon DA-15P plug. Any 9 basic oscillators may be used on 9 different RDB channels. Inputs and outputs individually adjustable. Standard 0-3 v input sensitivity.

Linearity: $\pm 0.5\%$ of band width. Power: 30 milliwatts per oscillator. Stability: Drift less than $\pm 3\%$ of full band width. Vibration: 30 G acceleration up to 500 cps. Shock: Up to 100 G. Input: .5 megohm. Output: Sine wave, 1% distortion. Designed to operate as package unit with mixer. Call or write for complete information.

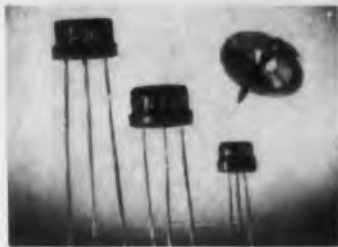


DORSETT *Laboratories, Inc.*

Tel. JE 4-3750

Box 862 • • Norman, Okla.

CIRCLE 188 ON READER-SERVICE CARD



**PNP Transistors
For Audio Applications**

Twelve germanium pnp transistors for audio applications have been announced. Six in the JETEC-30 package are for driver and output use as follows: Types 2N362 and 2N363 are drivers with average beta ratings of 90 and 45 respectively. Type 2N422 is a low noise unit with maximum noise factor of 6 db. Types 2N359, 2N360 and 2N361 are all capable of 500 mw output in Class B but differ in beta and power gain ratings.

The other six types are in a smaller package having a total volume of 0.004 cu in. approx. Types 2N130A, 2N131A and 2N132A are amplifiers with beta ratings of 22, 45 and 90 respectively. 2N133A is a low noise amplifier with maximum noise factor of 6 db. 2N138B is an output type capable of 50 mw in Class B. Type CK754 is a high gain transistor with an average beta of 300.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 189 ON READER-SERVICE CARD

**Voltage Divider Adapter
Extends Range of R-F Voltmeter**



A voltage divider adapter, designated Model 91-7A, has been developed for use with the Model 91B r-f Voltmeter to extend its voltage range and raise its input resistance. The Model 91-7A is a capacitance divider with a step-down ratio of 100:1 thus converting the 0.001 to 3-v range of the 91-B voltmeter to 0.1 to 300 v. Frequency range of the divider is 500 kc to 500 mc, with self-resonance at 900 mc. Shunt resistance approaches 100 meg at low frequencies and 1 meg at 100 mc. Shunt capacitance is 2.5 μf . Another feature is that the full-wave square law region of the 91-B voltmeter is thus extended permitting rms response to approximately 10 v.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

CIRCLE 190 ON READER-SERVICE CARD



Even when set at an illogical, illegible angle, Beckman Expanded Scale Voltmeters read

RIGHT at a glance

BECKMAN EXPANDED SCALE VOLTMETERS always read billboard-clear, even when the installation's angular, tangular, bothersome or bewildering. Needle position tells all—you don't have to read the fine type.

HOW COME? The meter's selective: non-essential parts of the scale have been eliminated, and the useful portion expanded. And so we bid farewell to crowded divisions at one end of the scale. Instead, meet real easy reading.

AC OR DC? Either. Also, they're as small as 2½" dia., as accurate as 0.3% of center-scale voltage. Resolution's as high as 0.1 volt.

HOW MANY MODELS? The 126 standard models—available in commercial and military versions—are for panel installations in ground power facilities, test equipment and aircraft. On special order, meters can be adapted for non-standard voltage ranges, scales, accuracies, shapes and sizes.

WANT MORE? Write for data file 114C.

Beckman / **Hollpot**
Corporation

*Newport Beach, California
A division of
Beckman Instruments, Inc.
Engineering representatives
in principal cities*

1172

CIRCLE 191 ON READER-SERVICE CARD

ANNOUNCING

VARIABLE VACUUM CAPACITORS

Actual size illustrations



Series A

Series B

Series C

**IN HIGH ALUMINA CERAMIC ENVELOPES
FOR LOW LOSS AND HIGH TEMPERATURE OPERATION**

The three capacitors illustrated are product of a design and development project which has established a *break through* into higher practicality for variable vacuum capacitors. They have great appeal in applications where technical, physical and cost factors have heretofore been prohibitive. There are at present three *size groups*, each of which contains several types differing in capacitance range and voltage ratings.

The art of adjusting the position of elements within vacuum sealed electronic devices by use of a bellows arrangement substantially predates World War II. In this new range of capacitors UNITED ELECTRONICS has advanced this custom through associating it with the newer techniques of ceramic bodies as employed in modern miniaturized and ruggedized electron tubes. Ceramic to metal closures are doubly important in variable vacuum capacitors since moving internal parts are involved. Extremely close tolerance assemblies are made possible under conditions of high production mechanization.

Modern miniaturized circuitry, whether in air, liquid or in rigid encapsulation, will invite advantageous opportunities for these new ceramic VariVacs available in voltage ratings of from 1,000 to 25,000, and with maximum engaged capacitance values up to 500 uuf.

VAR VAC

The above Trade Mark symbolizes
Variable Vacuum Capacitors by
UNITED ELECTRONICS

Write for technical bulletin CDB-4

UNITED  ELECTRONICS, 42 Spring Street, Newark 4, N. J.

New Products

Plastic Wire Harness

Zipper Closed

Called Tal-Pres Tube, this cable harness is a 0.02-in. clear vinyl plastic material fabricated to fit over and hold wire harness in position without primary fastenings such as lacing or spiral wound tape. It is supplied in roll form and is applied as a longitudinal covering. The seam fastening is a patented precision formed extrusion that is closed with a small removable zipper type device. The closure is an integral part of the tubing and provides a watertight, airtight, joint that can be made permanent when desired.

Pres Industrial Equipment, Ltd.,
Dept. ED, Box 319, New Paltz, N.Y.

CIRCLE 192 ON READER-SERVICE CARD

DC Power Supplies

High Voltage to 50 KV



Series 1000 rack-mounting high-voltage dc power supplies are available in sixteen basic models with outputs from 0-1 to 0.50 kv at from 2 to 500 ma. Typical of the series is model 1050-5. This unit has a range of 0-50 kv at 0-5 ma, 1 per cent ripple, 6 ma fixed overload, 40 per cent regulation, and 420 va input at 117 V. It has a 21 in.-high panel, and weighs 125 lb (with oil). The 1050-5 is also available in a more elaborate version for research and development work. The latter version includes fine control of high-voltage output to approximately 0.03 per cent of maximum.

Beta Electric Div., Sorensen & Co.,
Inc., Dept. ED, 333 E. 103rd St., New
York 29, N.Y.

CIRCLE 193 ON READER-SERVICE CARD

◀ CIRCLE 211 ON READER-SERVICE CARD

Fixed Delay Line 3000 μ Sec Delay



Designed for use as a component or as test equipment in computer and radar systems, this fixed delay line offers a 3000 μ sec delay, ± 5 per cent standard tolerance. The unit has a 3 db bandwidth of 5 kc. Insertion loss is 5.5 db.; impedance, 510 ohms ± 5 per cent. Outside dimensions are 4 x 10 x 8 in. The unit can be tapped as required.

ESC Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N.J.

CIRCLE 195 ON READER-SERVICE CARD

Telemetering Diplexers For 100 w Systems



Type 1231 Telemetering Diplexers feed signals from two 100 w transmitters into a single missile antenna system. Environmental specifications are: shock to 100 g, vibration to 20 g at 2000 cps, temperature range of -70 to 350 F. Units made of Invar may be provided for use up to 500 F. Other specifications include a frequency range fixed-tuned between 215 to 250 mc; isolation of 28 db with 10-mc separation and 25 db with 6-mc separation; attenuation of less than 0.3 db; power-handling capacity rated at 100 w cw; size of each cavity approximately 3 x 4 in. and weight of total system is 3.7 lb (two diplexers plus circuitry). Diplexer cavities are filled with dry air and permanently sealed.

Hycon Eastern, Inc., Dept. ED, 75 Cambridge Pkwy., Cambridge 42, Mass.

CIRCLE 196 ON READER-SERVICE CARD

CIRCLE 197 ON READER-SERVICE CARD >

The INCREDIBLE SHRINKING RESISTOR...

Daven has always been the leader in the miniaturization of precision wire wound resistors. Now, due to further advances in resistor manufacture, Daven is able to offer higher resistance values in smaller sizes than ever before. Typical miniature units, with their new maximum values, are tabulated here.

For guided missiles, airborne radar, telemetering, and for any application where extremely small size

and dependability are of prime importance, specify Daven miniature wire wounds.

TYPE	DIAM	LENGTH	MAX WATTS	MAX OHMS
1250	1/4	1/2	.33	1 Megohm
1274	3/16	3/8	.25	250 K
1284	1/4	27/64	.25	1 Megohm

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN  STANDS FOR DEPENDABILITY!



profit

taxes

labor

finance

sales

marketing

obsolescence

manufacturing



The Only Weekly Newsmagazine that helps the engineer with his Business Problems



Electronic executives are confronted with a maze of business problems unrelated to the technical problems which surround their products. *Electronic Week* is designed and written with the prime purpose of aiding the engineer-executive with these business problems. *Electronic Week* concerns itself with the trends and significant developments in marketing, manufacturing, labor, finance, taxes, profits, people and plants — brings this concise, timely information to your desk each Monday morning. By January 1st publisher's guarantee will exceed 10,000 copies.

a HAYDEN publication

New York 21: 19 East 62nd Street. TEmpleton 8-1940
 Chicago 11: 664 North Michigan Ave. SUperior 7-8054
 Los Angeles 36: 5720 Wilshire Blvd. WEbster 8-3881

New Products

Ferrite Bead Chokes

High Frequency

This series of four ferrite bead chokes range from 0.3 to 1.3 μ h with 30 mc ac resistance of 25 to 100 ohms. Designated for use as filament chokes, parasitic suppressors, and series elements of low-pass filters for frequencies of from 5 to 200 mc. Each will handle 2 amp filament current with a voltage drop of less than 0.02 v.

National Company, Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 199 ON READER-SERVICE CARD



Ball Plungers

Self-Locking

These ball plungers are used in indexing, locating, and positioning applications, and as detents. Each plunger is permanently fitted with a resilient, Nylok pellet which keeps them positioned without checknuts. As the plunger is inserted into a tapped hole, the pellet is compressed, exerting a spring-like pressure.

Vlier Engineering Inc., Dept. ED, 8900 Santa Monica Blvd., Los Angeles 46, Calif.

CIRCLE 200 ON READER-SERVICE CARD

Mylar Dielectric Capacitors

Flat and Round



Type XPR and XPF, dielectric capacitors are designed for minimum size and capacitance stability. A Mylar polyester outer wrap affords protection against moisture, and ends are sealed with a thermosetting resin. Voltage rating is 150 v at 85 C and 100 v at 125 C.

Astron Corp., Dept. ED, 255 Grant Ave., East Newark, N.J.

CIRCLE 201 ON READER-SERVICE CARD



Soldering Iron
1000 F from 12 V DC

Model 25 pencil soldering iron operates on 2 v, 2 amp, either ac or dc. Designed for high temperature precision soldering, it weighs less than one ounce and achieves tip temperatures of 1000 F while handle remains cool. It can be operated from a battery supply or 110 v ac using step-down transformer also available through the company.

Oryx Co., Dept. ED, 9015 Wilshire Blvd., Beverly Hills, Calif.

CIRCLE 202 ON READER-SERVICE CARD

Limit Switches

Snap Action

A packaged pair of snap-action limit switches for attachment to a 1-in. potentiometer has been made available. The switch has a range of angles from 0 to 360 deg and can be preadjusted to operate over this range of angles. The switch action is compact, requiring approximately 1/2 in. additional length on a 1-in. potentiometer gang. Technology Instrument Corp. of Calif., Dept. ED, 7229 Atoll Ave., N. Hollywood, Calif.

CIRCLE 203 ON READER-SERVICE CARD

True RMS Voltmeter

Determines Noise Level

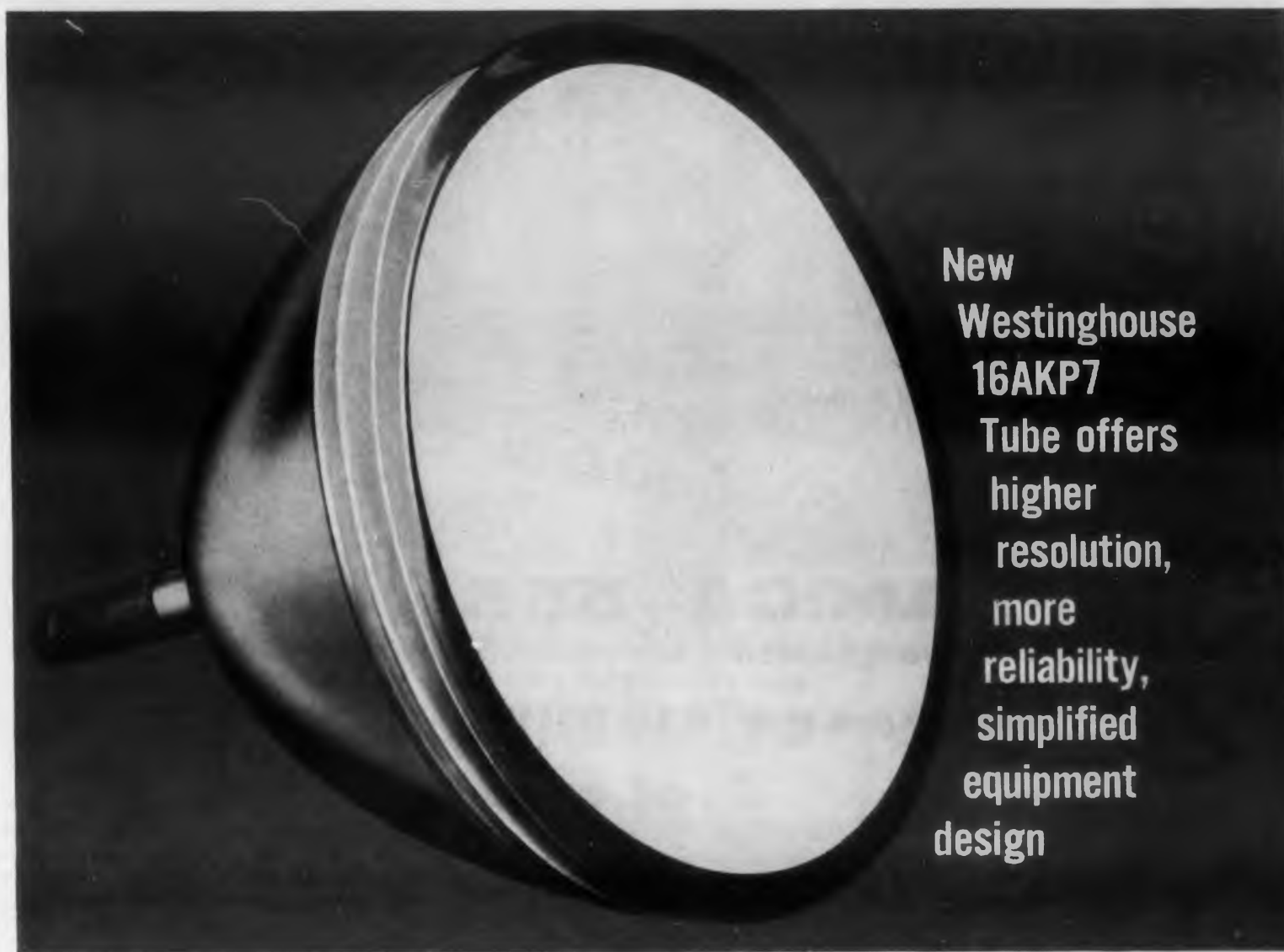


Model 14A voltmeter is particularly suitable for measuring the true rms magnitude in noise-figure determinations and in making noise-level measurements of equipment operating at audio and carrier frequencies. It utilizes a thermo-milliammeter, a transistor amplifier, and a coaxial input attenuator to provide full-scale indication for input voltages from 0.5 mv to 200 v. Readings from 15 cps to 500 kc are provided. Voltage differences of 0.5 per cent can be detected.

Consolidated Electrodynamics Corp., Alectra Div., Dept. ED, 325 North Altadena Drive, Pasadena, Calif.

CIRCLE 204 ON READER-SERVICE CARD

First all-glass 16" RADAR DISPLAY TUBE commercially available!



New
Westinghouse
16AKP7
Tube offers
higher
resolution,
more
reliability,
simplified
equipment
design

Here's the first all-glass 16" cathode ray tube available to the military equipment designers. Built by Westinghouse for radar, missile and computer display equipment . . . it outperforms 16" metal cone tubes.

The Westinghouse 16AKP7 has higher resolution. It is more reliable. It means less equipment complication (no need to insulate entire cone of tube). It features magnetic deflection, low-voltage electrostatic focus, and P7 phosphor.

Typical operating characteristics: Anode voltage: 12,000 volts. Grid 4 (focus) voltage: -300 to +250 volts. Line width:

0.025" at 100 microamps anode current. Grid 1 volts for cut-off: -35 to -75 volts.

Write for detailed data today on the new 16AKP7. Also write for information on type 12ABP7A, which will soon be available.

YOU CAN BE SURE...IF IT'S

Westinghouse

Electronic Tube Division Elmira, N. Y.

CIRCLE 205 ON READER-SERVICE CARD

CLIP AND MAIL COUPON

Commercial Eng. Dept., Electronic Tube Div.
Westinghouse Electric Corp., Elmira, N. Y.

Please send me complete information on the following tubes: _____ 16AKP7 _____ 12ABP7A.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

design achievements with SUPRAMICA* ceramoplastics



OSCILLATOR WITH SUPRAMICA 555 CERAMOPLASTIC BASE



SIGNAL CORPS' NEW VEHICULAR RECEIVER-R745 (1)/VRC

SUPRAMICA* 555
ceramoplastic insulation
increases stability
of new
AVCO
STABLE OSCILLATOR

Ceramoplastic's dimensional stability maintains frequency under extreme conditions to ± 6 kc at 40 mc without crystals . . . doubles channel capacity.

In one version of the Signal Corps' New Vehicular Receiver R-745 (1)/VRC is an advanced tuning unit that eliminates the requirement for many conventional crystals and their accompanying spurious heterodyning problems. Designed for "automated" assembly by the AVCO Manufacturing Corporation, Crosley Division, this extremely stable tuner utilizes a unique continuously tunable oscillator circuit, consisting of silver ribbon, precision-molded in a base of SUPRAMICA 555 ceramoplastic. The total dimensional stability of the insulation reduces the receiver's frequency drift to only .015% (32.5 - 57.5 mc) over a temperature range from -55° C to $+75^{\circ}$ C. This, in effect, doubles the number of usable channels on the equipment's allotted frequency by permitting 50 kc adjacent channel operation.

Crosley engineers conducted extensive tests before specifying SUPRAMICA 555 ceramoplastic and found that **no other insulating material** provided all the properties required: mass reproducibility with negligible variations, extremely low electrical loss, dependable high temperature operation, insignificant moisture absorption, high dielectric strength and total dimensional stability.

This is just one of thousands of SUPRAMICA ceramoplastic products, produced by MYCALEX CORPORATION OF AMERICA for leading manufacturers. The special formulation of SUPRAMICA . . . high quality electrical glass -- bonded with SYNTHAMICA,* synthetic mica . . . can help solve many of your design problems. Send for full technical information.

*SUPRAMICA is a registered trade-mark of the MYCALEX CORPORATION OF AMERICA. 555 and SYNTHAMICA are trade-marks of the SYNTHETIC MICA CORPORATION.

MYCALEX
CORPORATION OF AMERICA



GENERAL OFFICES AND PLANT:
CLIFTON BOULEVARD,
CLIFTON, NEW JERSEY

EXECUTIVE OFFICES:
30 ROCKEFELLER PLAZA,
NEW YORK 20, N. Y.

SALES OFFICES:
CHICAGO - DAYTON
LOS ANGELES - MIAMI
WASHINGTON

World's largest manufacturer of glass-bonded mica and ceramoplastic products

New Products

Miniature Connectors
Meet E Specifications



Named MinniE, these connectors are described by the company as being the first miniatures fully conforming to the E performance requirements of MIL-C-5015C. The connectors are available in potting, cable clamp, and jacketed cable types. Temperature limits are -67 to $+257$ F. Voltage ratings are 500 v rms at sea level and 600 v rms at sea level. No derating for altitude is necessary at 70,000 ft.

Amphenol Electronics Corp., Dept. ED, Chicago 50, Ill.

CIRCLE 207 ON READER-SERVICE CARD



Toroid Coils
For High Frequency

The MQD series of stabilized toroid coils for high frequency applications are rated from -40 to $+85$ C. The series consists of six different types ranging from 2 mh to 20 mh inductance. The Q is 170 at 50 kc, ranging down to approximately 80 at 12 kc and 130 kc. The MQD units are hermetically sealed to MIL-T-27A specifications.

The United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

CIRCLE 208 ON READER-SERVICE CARD

◀ CIRCLE 206 ON READER-SERVICE CARD

Tubular Delay Lines Semi-Adjustable



Semi-adjustable, model 107 tubular delay line has a maximum delay length specified by user and is adjustable over the range of 5 μ sec. Adjustment is made by turning a sleeve along the threaded body. Intermediate pickoff may be specified as required. Body diameter is 1-1/8 in. maximum, with length of tubular casing dependent upon the delay factor.

Delttime, Inc., Dept. ED, 608 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 209 ON READER-SERVICE CARD

X-Band Duplexer Low Arc Loss



Designated the MA-306B, this X-band dual TR tube is intended for use with short-slot hybrid couplers. Design of the duplexer reduces arc loss to 0.6 db at 40 kw peak power. Other major electrical characteristics are a peak power rating of 500 kw; average power rating of 500 w; vswr of 1.2 max from 8490 to 9578 mc; flat leakage power of 10 mw; spike leakage of 0.1 erg, and a recovery time of 7 μ sec at 500 kw peak power. Input and output flanges mate with hybrid couplers in RG-51/U and RG-52/U waveguide respectively.

Microwave Associates, Inc., Dept. ED Burlington, Mass.

CIRCLE 210 ON READER-SERVICE CARD

CIRCLE 194 ON READER-SERVICE CARD



MINIATURE TRANSISTOR TRANSFORMERS from stock!

MICROTRAN transistorized transformers are ruggedized, military-type components developed to meet the growing demand for miniaturization. Design and performance meets or exceeds all applicable commercial and government specifications including MIL-T-27A, MIL-E-5400, CAA-R-777, etc. Write TODAY for catalog and price list of the complete MICROTRAN line.



MINIATURE TRANSISTOR TRANSFORMERS

Available in 8 case types (see catalog)

Hermetic (H) 15/16" x 1-3/8" x 1-7/8", wt. 1-1/4 oz.

Molded (M) 7/8" x 7/8" x 1-15/32", wt. 1-3/4 oz.

Open Frame (F) 3/4" x 1" x 13/16", wt. 1 oz.

Part No. *	Application	Pri. Imp.	Sec. Imp.
MT1*	Line to emitter	600	600
MT3*	Coll. to emit. or line	50,000	600
MT5*	Collector to speaker	50,000	6
MT6*	Collector to P.P. emitter	100,000	1200 C.T.
MT7*	Collector to P.P. emitter	25,000	1200 C.T.
MT8*	P.P. Coll. to P.P. emit.	50,000 C.T.	1200 C.T.
MT9*	Line to P.P. emitter	600 C.T.	1200 C.T.
MT10*	Collector to emitter	25,000	800
MT11*	P.P. Collector to P.P. emitter or line	4,000 C.T.	600 C.T.
MT12*	Output coll. to speaker	2,000	3.4
MT13*	Output P.P. coll. to spkr.	4,000 C.T.	3.4

SUB-MINIATURE TRANSISTOR TRANSFORMERS

Available in 5 case types (see catalog)

MIL Case (AF) 1-1/8" x 3/4" x 3/4", wt. 1-1/8 oz.

Hermetic (H) 15/16" dia. x 15/16", wt. 1 oz.

Open Frame (F) 9/16" x 11/16" x 7/8", wt. 6 oz.

Part No. *	Application	Pri. Imp.	Sec. Imp.
SMT1*	Line to emitter	600	600
SMT3*	Collector to emitter or line	50,000	600
SMT5*	Collector to speaker	50,000	6
SMT7*	Coll. to P.P. emit.	25,000	1200 C.T.
SMT10*	Collector to emitter	25,000	600
SMT12*	Output collector to speaker	2,000	3.4
SMT13*	Output P.P. collector to speaker	4,000 C.T.	3.4

MICRO-MINIATURE TRANSISTOR TRANSFORMERS

Available in 4 case types (see catalog)
Hermetic (H) 15/16" dia. x 11/16", wt. 3/4 oz.
Open Frame (F) 7/16" x 19/32" x 3/4", wt. .4 oz.

Part No. *	Application	Pri. Imp.	Sec. Imp.
MMT1*	Line to emitter	600	600
MMT3*	Coll. to emit. or line	50,000	800
MMT4*	P.P. coll. to P.P. emit.	50,000 C.T.	600 C.T.
MMT5*	Collector to speaker	50,000	6
MMT7*	Coll. to P.P. emitter	25,000	1200 C.T.
MMT8*	P.P. Coll. to Emit.	50,000 C.T.	1200 C.T.
MMT9*	Line to P.P. Emitter	600 C.T.	1200 C.T.
MMT10*	Collector to emitter	25,000	600
MMT11*	P.P. Coll. to P.P. Emit.	4,000 C.T.	600 C.T.
MMT13*	P.P. Coll. to speaker	4,000 C.T.	3.4

VERI-MINIATURE TRANSISTOR TRANSFORMERS

Wt. .16 oz. size 7/16" x 7/16" x 1/2"
Nylon Bobbin, Nickel-Alloy Core
4" color coded leads, resin impregnated

Part No.	Application	Primary Impedance	Secondary Impedance
VM1-F	Input	50	600 (1.5ma)
VM2-F	Input or Interstage	200,000	600 (1.0ma)
VM4-F	Input or Interstage	200,000	1200 (.72ma)
VM5-F	Interstage	50,000	600 (1.0ma)
VM7-F	Output	500 (3.5ma)	3.4
VM8-F	Output	1250 (2.0ma)	3.4
VM9-F	Output	1250 (2.0ma)	50
VM11-F	Choke	20 hy. (0ma)	12 hy. (5ma)

ULTRA-MINIATURE TRANSISTOR TRANSFORMERS

Wt. .08 oz. size 3/8" x 3/8" x 11/32"
Nylon Bobbin, Nickel-Alloy Core
4" color coded leads, resin impregnated.

Part No.	Application	Primary Impedance	Secondary Impedance
UM21-F	Input	100,000	1,000
UM22-F	Driver	20,000	1,000
UM23-F	Driver	20,000	1,200 C. T.
UM24-F	Output	1,000	50
UM25-F	Output	400	50
UM26-F	Output	400	11
UM27-F	Output	400 C. T.	11
UM28-F	Choke	10 hy. (0 dc)	

TRANSISTOR DRIVER TRANSFORMERS

See catalog for frequency response, size and case type.

Part No.	Typical Application	Pri. Imp.	Sec. Imp.	Pri. Unbal. D.C. Ma.
M2314	Col. to P.P. Emit. 2N95, 2N68, 2N57	100	10 C.T./40 C.T.	100
M8126	Col. to P.P. Emit. 2N57	560	400 C.T.	18
M2181	Col. to P.P. Emit.	625	100 C.T.	10
M2305	Col. to P.P. Emit. 2N43, 951	5,400	600 C.T.	15
M2429	Col. to P.P. Emitter. 953	7,000	320 C.T.	7
M2581	Col. to P.P. Emit. 2N190, 2N109, 2N44	10,000	6,500 C.T.	.75

*Add either -AG, -H, -M, -F, -FB, -FPB, -A, or -P to Part No. to designate construction. See catalog for detailed information.

TRANSISTOR OUTPUT TRANSFORMERS

See catalog for frequency response, size and case type.

Part No.	Typical Application	Pri. Imp.	Sec. Imp.	Level
M2182	P.P. Output Auto-Transf. 2N156	9 C.T.	4	2w.
M2576	Output 2N156, 2N176	25	3-4	3w.
M2313	P.P. Output 2N156, 2N68, 2N95	48 C.T.	3.2/8	5w.
M2577	P.P. Output 2N188A	125 C.T.	3-4	1.5w.
M2578	P.P. Servo Output 2N57	140 C.T.	500	6w.
M2251	P.P. Audio Output 2N43, TS161	250 C.T.	3-4	250mw.
M2158	P.P. Servo Output 2N43, TS161	250 C.T.	1,000	1w.
M2579	Collector to Spkr. 2N179	400	10	300mw.
M2326	P.P. Audio Output 2N180, 2N108	400 C.T.	11	300mw.
M8127	P.P. Servo Output 2N57	500 C.T.	210	2.5w.
M2430	P.P. Servo Output 970	1600 C.T.	800	2.5w.
M2580	P.P. Audio Output 350, 2N241, 2N44, 2N109	2550 C.T.	12	100mw.

FRANCHISED STOCKING DISTRIBUTORS

Dean's Electronics 2310 American Avenue Long Beach, California	Peerless Radio Distributors 92-32 Merrick Rd. Jamaica, New York
Graybar Electric Co. 210 Anderson St. Los Angeles, California	Arrow Electronics Inc. 525 Jericho Turnpike Mineola, New York
W. D. Brill Co. 610 E. 10th Street Oakland, California	Arrow Electronics Inc. 65 Cortland St. New York City, N. Y.
Moses Radio Electronics Co. 330 Locust St. Hartford, Connecticut	Wolmar Distributors 417 Columbia St. Utica, New York
Kenyon Radio Supply Co. 2020 14th St., N.W. Washington, D. C.	Oh! Capitol Electronics Corp. 2325 East 4th St. Tulsa, Oklahoma
Electrical Supply Corp. 205 Alewife Brook Parkway Cambridge, Massachusetts	Harold H. Powell Co. 2102 Market St. Philadelphia, Pa.
Harry Stark's Inc. 71 South 12th St. Minneapolis, Minnesota	Montague Radio Supply 760 Laurel Beaumont, Texas
Federal Purchaser, Inc. 1021 U.S. Route 22 Mountainside, N. J.	C & G Radio 2502 Jefferson Ave. Tacoma, Washington

MICROTRAN

company, inc., 145 E. MINEOLA AVE., VALLEY STREAM, N. Y.

I-S solves tough production problem

—to meet critical

ELECTRO SNAP

SPRING "SPECS"



OVERLAP ON CONTACT POINTS WAS CONSIDERED IMPOSSIBLE TO MASS-PRODUCE. I-S ENGINEERS PRODUCED THE PART WITH PRECISION TO SPARE

Hermetically Sealed Limit Switch employs I-S Beryllium Copper Flipper Blades

- FOR SUPER PRECISION ACCURACY
- COMPLETE FREEDOM FROM FATIGUE

The Electro-Snap component illustrated is hermetically sealed, ruggedly constructed to provide an environment-free, super-durable limit switch. The I-S flipper blades of beryllium copper offer excellent electrical characteristics, super precision accuracy and freedom from fatigue. If you have a spring problem, I-S engineers will be happy to explain the unique advantages of Beryllium Copper and make specific recommendations.

Write or call today for the I-S catalog on Beryllium Copper compression springs, flat springs, strip springs, contact strips, contact rings and screw machine parts.

INSTRUMENT SPECIALITIES CO • INC

270 Bergen Blvd., Little Falls, New Jersey
Telephone: Little Falls 4-0280



CIRCLE 212 ON READER-SERVICE CARD

New Products



Anti-Backlash Gears
24 to 200 Pitches

These anti-backlash gears are available from stock in 24 to 200 pitches and are made with bores ranging from 1/8 to 1/4 in. diam. Materials are stainless steel, aluminum, and bronze.

Pic Design Corp., Sub. of Benrus Watch Co., Inc., Dept. ED, 477 Atlantic Ave., East Rockaway, N.Y.

CIRCLE 213 ON READER-SERVICE CARD

Beam Switching Tubes High Input Z, 10 Outputs



This line of magnetron beam switching tubes has high input impedance and ten individual constant current outputs. Type 6700 operates between 75 to 300 v with a switching rate above 2 mc, and Type 6701 operates from 12 to 25 v with a switching rate above 1 mc. Type MO-10R has ten internally mounted space load vacuum resistors to permit operation at higher frequencies.

Burroughs Corporation, Electronic Tube Div., Dept. ED, Plainfield, N.J.

CIRCLE 214 ON READER-SERVICE CARD



Induction Motor
For Blower Drives

This cps induction motor has been designed for blower drives or general purpose induction drive motor applications. A 1-in. diam. unit, it operates directly from 115 v, 60 cps line without the use of step down transformers or dropping resistors. The motor has a stall torque of 0.7 oz. in. and a running torque of 0.4 oz.-in.

Eastern Air Devices, Dept. ED, Central Ave., Dover, N.H.

CIRCLE 215 ON READER-SERVICE CARD

An Engineer Speaks Out...

Exciting Thriller Breaks Model Shop Mystery



This saga of the intrepid investigator veers off on a taut and timely theme — the engineering enigma of that inexplicable time lag in getting new servosystem designs into prototype form. Scene of the crime, written in a tempo of gore and gusto, is cued by the title — MURDER IN THE MODEL SHOP.

There's a switch in the pitch of this turbulent tale . . . no one seems to care who done it! The question is, what can be done about it. And this crime has its solution too, but agreement with the publisher precludes revealing the denouement here.

A possible clue to the answer is suggested by the sleuth's bringing in his trusty SERVBOARD®, that life-saving instrumentality for assembling models or prototypes of systems in jig time. The SERVBOARD is armed with a rigid aluminum base plate perforated with tapped holes, and a comprehensive range of gear sets, dial assemblies, hangers, clamps, and other hardware for summary execution of any and all servo designs.

And if there's any question whether the varmint is a true mechanism or a machination, the SERVSCOPE® beats out any lie detector ever concocted — gets the facts, ma'am, on gain, and phase lead or lag, digs the figures for plotting Nyquist diagrams, sings out with the square wave for transient functions.

With the latest edition now coming off the press, MURDER IN THE MODEL SHOP contains fifty pulse-packed pages — printed on genuine pulp. You've never had such an adventure in lurid lingo, even at many times the price which is exactly nothing . . . to engineering and design people.



SERVO
CORPORATION
OF AMERICA

20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Write, wire, or call for your free copy of MURDER IN THE MODEL SHOP, published by SERVO CORPORATION of America.

The publisher also produces SERVBOARD, SERVSCOPE Servosystem Analyzer, etc.

CIRCLE 216 ON READER-SERVICE CARD

Travelling Wave Tubes

Light Weight

The three types of these travelling wave tubes provide band coverage from 2000 to 12,000 mc. The tube itself weighs 2 oz, and with solenoid for 10 mw output, the assembly weighs 2-1/4 lb. The 1-w version weighs 4 to 5 lb. Three point suspension is provided for strength.

Geisler Labs., Dept. ED, P.O. Box 252, Menlo Park, Calif.

CIRCLE 217 ON READER-SERVICE CARD



Indicator Lights

Individual or in Strips

Called Digicator lights, these units are available individually, in pre-assembled strips, or as custom-built assemblies. To allow sockets to be grouped closely together, the usual mounting nut and lockwasher have been replaced with an integral collar which is flared to the mounting surface. Both round or square lenses, accommodating AN3140-type incandescent or neon lamps, are available. Square lenses may be removed individually from multiple installations.

Hetherington, Inc., Dept. ED, Delmar Dr., Folcroft, Pa.

CIRCLE 218 ON READER-SERVICE CARD

Ferrite Memory Core

Switching Time of 1.5 μ sec

Measuring 0.075 in. od x 0.048 in. id x 0.022 in. thick, these ferrite memory cores have been designated as M-2. The cores operate at 670 ma full current and have a switching time of less than 1.5 μ sec. They are immediately available for computer applications.

Ferroxcube Corp. of America, Dept. ED, 50 E. Bridge St., Saugerties, N.Y.

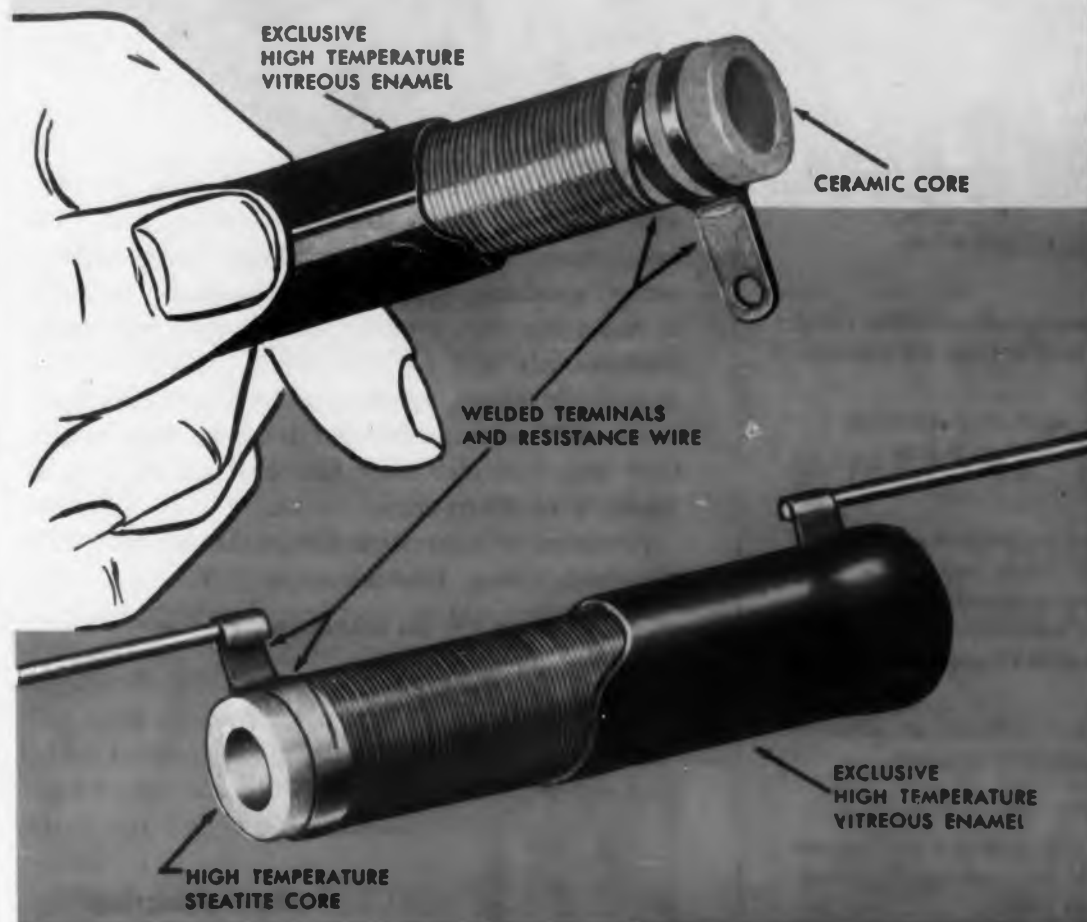
CIRCLE 219 ON READER-SERVICE CARD

CIRCLE 220 ON READER-SERVICE CARD

OHMITE®

WIRE-WOUND, VITREOUS-ENAMELED

POWER RESISTORS . . . *industry's most complete line*



WELDED RESISTANCE WIRE Ohmite Resistors have the resistance wire welded to the terminals instead of soldered or brazed. This provides a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

WELDED TERMINALS Another Ohmite Resistor feature is the welded terminal band. The band is permanently held together around ceramic core by means of welding, providing a strong, permanent fastening.

STRONG CERAMIC CORE This strong, rugged core has excellent electrical characteristics, and is unaffected by cold, heat fumes, or high humidity.

EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of core, terminal, and resistance wire.

Ohmite offers resistors in more than 60 sizes—ranging from 2 1/2" diameter by 20" long to 1/4" diameter by 9/16" long—to meet your exact requirements. **MANY SIZES ARE CARRIED IN STOCK.**

Ohmite offers the most complete line of wire-wound, vitreous-enameled POWER RESISTORS on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes, types of terminals . . . available in a wide range of wattages and resistances.

Write on company letterhead for Catalog No. 40.

BE RIGHT WITH

OHMITE®

RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3643 Howard Street
Skokie, Illinois



GENERAL ELECTRIC

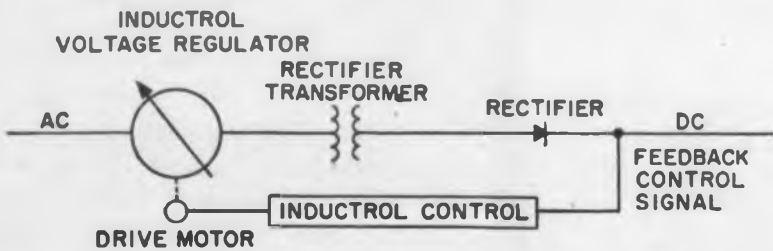
VOLTAGE REGULATION IDEA FILE

by C. A. Neumann



ENGINEERING DESIGN IDEA: A.C. Controls D.C.

General Electric Inductrol® a-c induction voltage regulators can control d-c voltage or current. Here's how:



Inductrol regulators compensate for a-c line variations, rectifier aging effects, regulation as d-c load current varies, hold voltage (or current) to $\pm 1\%$.

DESIGN BENEFITS: Inductrol regulator drift-free controls always keep voltage settings at desired level. Cost is low.

RADAR APPLICATION IDEA:

New England radar manufacturer uses three single-phase Inductrol voltage regulators to give precise individual phase regulation, hold voltage to $\pm 1\%$. In addition a three-phase, motor-operated, manually-controlled Inductrol regulator is used for tube warm-up. Power can be increased by raising voltage from 0 to 600 in either two seconds or 30 seconds.

DESIGN BENEFITS: Easy-to-install, Inductrol voltage regulators introduce no waveform distortion into electronic systems.

COMPUTER APPLICATION IDEA:

Massachusetts computer manufacturer got line stability and proper tube warm-up by using both voltage stabilizer and voltage regulator. One Inductrol voltage regulator now does both jobs.

DESIGN BENEFITS: Inductrol voltage regulators have an excellent space factor, require little maintenance. They neither affect, nor are affected by, system power factor.

HEAT TEST IDEA:

Boston electronics firm uses battery of infrared quartz lamps to simulate missile in-flight heat conditions. Lamps, energized suddenly on this 208-volt circuit produced rapid heat, but lack of warm-up time caused expensive lamp mortality. A complicated and expensive wiring-switching arrangement was considered, discarded in favor of 3-phase automatic Inductrol voltage regulator.

DESIGN BENEFITS: Inductrol voltage regulators have no brushes to maintain or replace; are rugged, designed for long life; are extremely accurate and reliable.

FOR MORE INFORMATION write Section 425-8, General Electric Company, Schenectady 5, N. Y.

* Trade mark of General Electric Company for Induction Voltage Regulators.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 221 ON READER-SERVICE CARD

New Products

Limit Stop

Precise Limit Over Wide Range



This multi-turn adjustable limit stop is available in two models, 0-10 revolutions and 0-40 revolutions. It features a single range-setting screw, available at the end cap, which is capable of adjusting stop rotation from zero to full scale continuously and with precision. The limit stop is 0.875 in. diam, synchro mounted, 1-5/32 long in the 0-10 turn model, and 1-7/8 in. long in the 0-40 turn model. Other features are its torque capacity of 40 oz in.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

CIRCLE 222 ON READER-SERVICE CARD



Multi-Function Synchro

Controls, Receives, and Transmits

The 3SYN is interchangeable with Mil torque transmitters, control transmitters, and torque receivers. They are stated to excel the critical ratings of standard Mil synchros in each of these three functions. Standard 3SYNs operate at 400 cps, and are available on order to operate to 10,000 cps. Temperature range is from -55 to +140 C. Frame size is no. 23. As a torque receiver, accuracy is $\pm 1/2$ deg and damping time is 1 sec. Torque gradient is 0.25 oz.-in. per deg. As a control transmitter, accuracy is 3 min. As a torque transmitter, torque gradient is 0.25 oz.-in.

Norden-Ketay Corp., Dept. ED, Commerce Rd., Stamford, Conn.

CIRCLE 223 ON READER-SERVICE CARD



THERE IS
ONLY ONE
GUDELACE:
THE
ORIGINAL
FLAT
BRAIDED
NYLON
LACING
TAPE
MADE BY
GUDEBROD

Gudebrod flat braided lacing tapes hold harness securely—no bite-through or slip, yet are easy on the hands. Some resist high temperature, some are color-coded . . . and they come wax-coated or wax-free . . . rubber-coated . . . or with special coating. Gudebrod makes many tapes for many purposes, including defense work. Send us your lacing problems or your specifications . . . we can supply the answer to both.

GUDELACE • GUDE-NYLACE
GUDELACE H • TEFLACE

GUDEBROD BROS. SILK CO., INC.

ELECTRONICS DIVISION

225 W. 34th St., New York 1, N. Y.

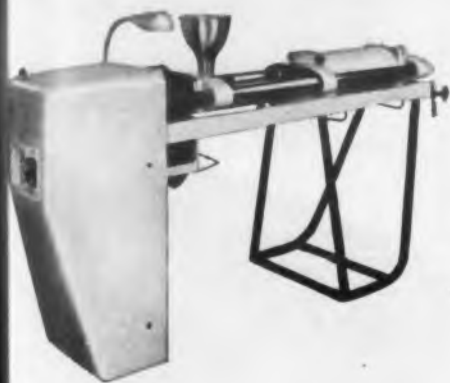
EXECUTIVE OFFICES

12 South 12th St., Philadelphia 7, Pa.

CIRCLE 224 ON READER-SERVICE CARD

now —
for small
plastic parts

“DO IT YOURSELF”



cut costs ..
avoid delays ..
improve quality ..
control production ..

... with the Hull Standard Model 99A completely automatic transfer Molding Press for thermosetting plastics that literally “works while you sleep.” Anyone, with minimum instruction, can supervise several presses.

Capacity up to 20,000 parts per week with 4-cavity mold. Utilizes conventional molding powders. No preforms or preheating required. Phenomenally low mold cost. Quick set-up and mold change-over.

Provides closer tolerances and greater strength in thin sections — facilitating miniaturization. Flash and finishing costs are minimized.

Write for information and technical paper “A new concept in Small Parts Molding.”

HULL-STANDARD
CORPORATION

Hatboro, Pennsylvania • Phone: OSborne 5-5000
Export Division: 1505 Race St., Phila. 2, Pa., U.S.A.

Also for High-Vacuum Potting,
Drying, Impregnating, Metal-
lizing Equipment — write Hull
Corporation.

CIRCLE 225 ON READER-SERVICE CARD



Inductance Bridge

Direct Reading from
1 μ H to 100 H

Type A 1100 direct-reading inductance bridge, has an accuracy of 0.1 per cent and measures inductances from 1 μ h to 100 h. Resolution is 0.01 per cent over much of the range. Maximum direct read-in accuracy is achieved between 50 and 3000 cps, while a table of small corrections is supplied to permit measurements up to 20 kc.

British Industries Corp., Dept. ED, 80 Shore Rd., Port Washington, N.Y.

CIRCLE 226 ON READER-SERVICE CARD

Printed Circuit Process

For Plated-Through Holes

A process for producing positive-etched printed circuits with plated-through holes has been made available. The process eliminates the need for gold or solder plating with resulting undesirable effects. Boards can be supplied either as bare copper circuits which can be bright dipped or fluxed prior to use, spray fluxed after etching (giving the boards a minimum of 6 months shelf life), or solder dipped with lead tin. The ratio of lead tin and the adherence of the solder is more easily controlled since it is not an electro plate and is applied on a finished copper circuit in the same manner as a single sided board.

Allied Allegri, Dept. ED, 141 River Road, Nutley, N.J.

CIRCLE 227 ON READER-SERVICE CARD



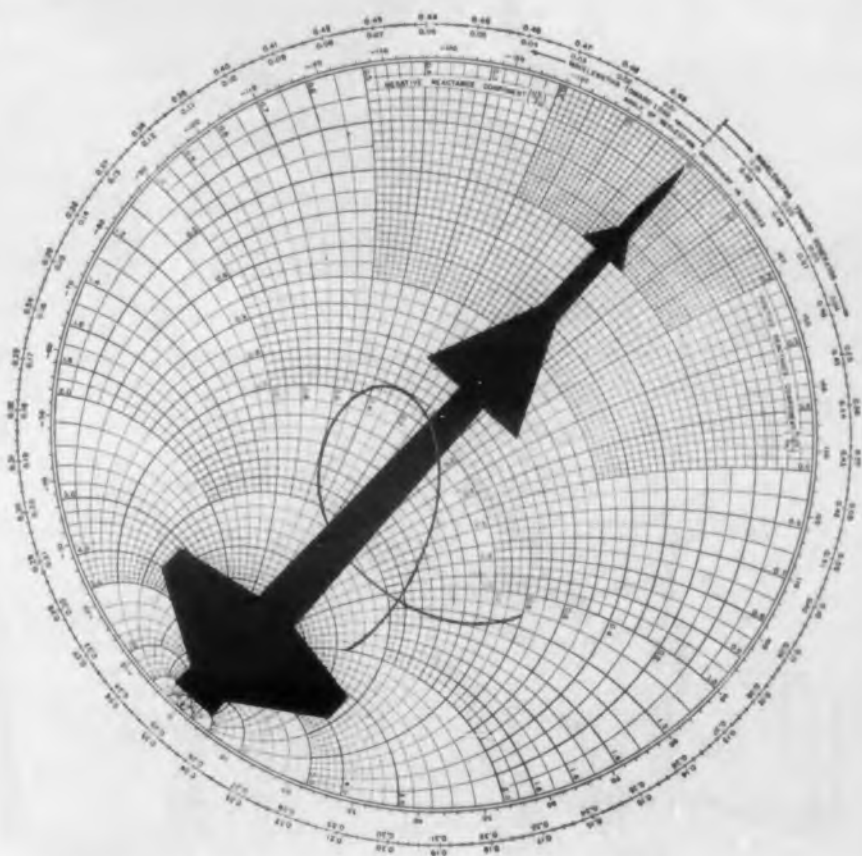
Mercury Battery Holder

Adapts to Various Sizes

Model 2324 five-cell mercury battery holder may be mounted directly to the chassis or printed circuit boards and will hold batteries under severe conditions of vibration and shock. The holder is completely electroplated and all parts are non-ferrous. A spring-loaded end support permits the use of batteries of varying length.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 45, Mass.

CIRCLE 228 ON READER-SERVICE CARD



WRAP IT UP WITH TRANSCO ANTENNAS

TRANSCO offers a single, competent source for all—or any part of your antenna program



Here is a technical staff and producing facilities. Here, too, are 10 years' experience in supplying a wide variety of approved antennas. We can serve you in Design, Development, Production Engineering and Manufacturing—all, or any combination.



STUDY AND DESIGN. We have experienced engineers who draw on broad knowledge. Their designs reflect a firm grasp of practical applications.



DEVELOPMENT. Once a satisfactory approach has been chosen, a test sample is "wrung out" in TRANSCO's radiation lab, RF lab and environmental lab.

PRODUCTION ENGINEERING—often the missing link—eliminates production delays. We're after design producibility, with a staff of liaison people that keeps design and production on the same track.



PRODUCTION. TRANSCO has the capability to support your own requirements. We maintain the highest standards of quality.

Transco is an active contributor to the ICBM and IRBM programs.

TRANSCO PRODUCTS, INC.

the finest in RF system components

12210 NEBRASKA AVENUE, LOS ANGELES 25, CALIFORNIA

REPRESENTATIVES IN MAJOR AREAS

CIRCLE 229 ON READER-SERVICE CARD







17 light-years late for dinner . . .

As everybody knows, space ships travel by cutting magnetic lines of force . . . and a supply of good permanent magnets is a "must" if you're going to make with the $E=mc^2$ in outer space. (Technical details on this are not quite ready for release.)

This wandering spaceman from Planet Plexippedes was making a routine flight over California and forgot to watch his flux density indicator. Suddenly—no power . . . and he had to limp home on his auxiliaries, to face an irate wife.

Too bad nobody told him about Thomas & Skinner's complete line of magnetic materials—permanent magnets, wound cores, laminations and SiFeMag tapes. T & S magnetic materials have proved ideal in literally thousands of industrial applications. No reason why they wouldn't be ideal for space ship installations, too.

**SPECIALISTS IN
MAGNETIC MATERIALS**

Permanent Magnets  Magnetic Tapes 
Laminations  and Wound Cores 



Thomas & Skinner, Inc.

1157 E. 23rd Street • Indianapolis, Indiana
CIRCLE 230 ON READER-SERVICE CARD

New Products

Regulated Filament Transformers Extend Tube Life



Designed to replace conventional unregulated filament transformers, this group of five static-magnetic regulated transformers produce a stable filament supply of 6.3 v. Regulation is within ± 1 per cent for line voltage variations as great as ± 15 per cent. Current limiting characteristic of the transformers restrict cold filament current. The transformers are available in current ratings of from 5 to 25 a, permitting the operation of banks of tubes from one filament supply.

Sola Electric Co., Dept. ED, 4633 West 16th St., Chicago 50, Ill.

CIRCLE 231 ON READER-SERVICE CARD



28-V DC Power Supply 100 A Rating

Model FR100 heavy duty convection cooled power supply operates on 208/220 v ac, 60 cps, three phase and is rated for continuous service at 0-30 v dc at 100 a. Ripple does not exceed 4 per cent of the average output throughout the range of the equipment. Regulation is approximately 8 to 10 per cent at 30 v. The unit features complete protection against internal failure, external short circuits or overloads, momentary power interruptions, low input voltage, rectifier thermal overload, and phase failure.

Opad Electric Co., Dept. ED, 69 Murray St., New York 7, N.Y.

CIRCLE 232 ON READER-SERVICE CARD



LIBRASCOPE SHAFT POSITION-TO-DIGITAL CONVERTERS

Equipped with ANTI-AMBIGUITY
DOUBLE BRUSH PICKOFFS

Useful in a wide variety of applications, including digital aircraft and missile controls, machine tool controls, digital readout from strip chart recorders, and as the modulator and de-modulator in pulse-code modulated radio links.

GRAY CODE MODEL - Capacity of 8 binary digits (single brush pickoff).

BINARY MODEL - Capacity of 7 to 19 binary digits.

BINARY CODED DECIMAL MODEL
Capacity range from 0-1999 to 0-35,999.

Units for special codes or capacities are built to meet specific requirements.

- SHOCK ENDURANCE.....20g
- TEMPERATURE RANGE...-50° to 83°C min.
- CODE DISCS.....Rhodium plated phenolic
- PICKOFFS.....Multiple wire brush.
Two pickoffs/channel
- ROTATION.....Continuous, either direction.

**RUGGED-NON-MAGNETIC-LONG LIFE
MAY BE READ WHILE IN MOTION**

**SPECIAL CONVERTERS DESIGNED TO MEET
YOUR INDIVIDUAL PROBLEMS**



Send for illustrated brochure

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

808 Western Avenue • Glendale, California

CIRCLE 233 ON READER-SERVICE CARD



Do you
think
of pressure
transducers?

Guided missile manufacturers do...

For example, the General Electric Missile and Ordnance Systems Department uses Statham Model PA203 pressure transducers on their missile programs.

The Model PA203 miniature pressure transducer mounts into a 3/4-16 fitting without zero shift from installation torque.

The transducing element is the rugged Statham unbonded strain gage. This model is available in ranges from 0-5 to 0-1,000 psia and is constructed to the exacting standards of sophisticated customers.

**WHEN THE NEED
IS TO KNOW...FOR SURE
SPECIFY STATHAM**

Please request Bulletin No. PA203

Statham

LABORATORIES

LOS ANGELES 64, CALIFORNIA

CIRCLE 234 ON READER-SERVICE CARD



I-F Amplifier 60 Mc Frequency Range

The Series 80 transistorized i-f amplifiers is now offered at frequencies up to 60 mc using either silicon or germanium transistors. Typical gain is 100 db, with a bandwidth of 3 mc at 30 mc center frequency. Components are mounted on a printed circuit board supported in a cast aluminum frame. Elimination of heat dissipation problems is one of their advantages.

Lel, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

CIRCLE 235 ON READER-SERVICE CARD

Transmission Line Calculator For VHF Line Length Corrections

A vhf transmission line calculator has been designed to speed and simplify line length corrections. Measurements are corrected and plotted directly on Z-O or Smith charts, which may have 50 ohm, 20 millimho, normalized, or any other scales. Operation is not limited by frequency, and eliminates the need for line stretchers, greatly extending the usefulness of vhf impedance and admittance bridges. Available with red or black markings and laminated in vinyl.

Radio Activities, Inc., Dept. ED, Boonton, N.J.

CIRCLE 236 ON READER-SERVICE CARD

Decade Scaler Five Units

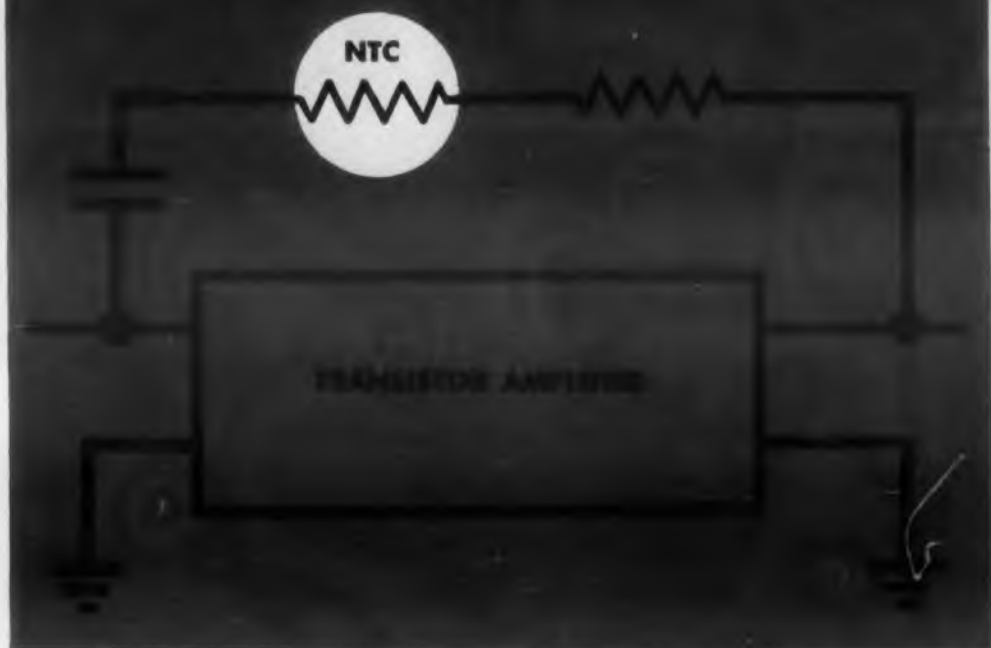


Model DS-5 decade scaler, has five plug-in decade units, plus the 100,000th unit indicator, permit a direct count up to 199,999 without the use of external registers. Overall resolution time is 1 μ sec per pulse pair. Pulse height control allows sensitivity to be varied to facilitate analysis of sample content.

Technical Associates, Dept. ED, 140 W. Provi-dencia Ave., Burbank, Calif.

CIRCLE 237 ON READER-SERVICE CARD

HOW THERMISTORS CAN HELP YOU



Compensating for Temperature Effect on Transistors with GLENNITE® Thermistors

Keeping transistor amplifier power gain constant has continually plagued computer design engineers. Recent experimentation using Glennite wafer thermistors has provided a simple, effective solution to this problem.

A temperature increase in the transistor amplifier circuit shown above causes an increase in power gain. To maintain constant gain, a Glennite wafer thermistor is placed in the feedback circuit. Negative temperature coefficient of the thermistor causes a decrease in resistance as the temperature increases. The resultant feedback degeneration compensates for the gain. Transistor gain control in computers is one of innumerable applications for versatile Glennite Thermistors. Wafer, bead, and rod configurations offer inexpensive solutions to thousands of temperature sensing, temperature compensation, amplitude control, measurements and analyses, and time delay problems.

Write for "HOW TO USE THERMISTORS." It outlines solutions to many of the above problems.



Thermistor Division
Gulston Industries, Inc.



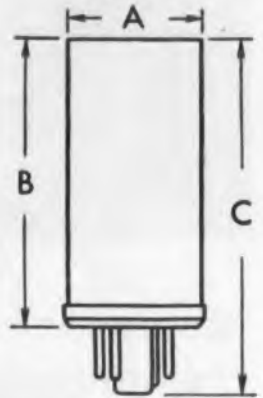
METUCHEN, NEW JERSEY

CIRCLE 238 ON READER-SERVICE CARD

Full Wave SILICON Tube Replacement RECTIFIERS



Where dependability and ruggedness are a "must," Full Wave Silicon Tube Replacement Rectifiers will solve your problems. One of the four standard types described below will meet the requirements of your application.



S-5011 1N1150

Maximum Rating:

Peak Inverse Voltage
per Section1600 Volts Max.
Peak Rectifier Current
per Section8000 MA Max.
DC Output Current750 MA Max.
Ambient Temperature100°C Max.

Dimensions:

A—1-1/2" O.D. B—2-1/4" C—2-27/32"
Four Pin Base

Replacement for Types 80, 82, 83, 83V, 5Z3

S-5017 1N1237

Maximum Rating:

Peak Inverse Voltage
per Section1600 Volts Max.
Peak Rectifier Current
per Section8000 MA Max.
DC Output Current750 MA Max.
Ambient Temperature100°C Max.

Dimensions:

A—1-3/16" O.D. B—2-19/32" C—3-5/32"
Octal base
Replacement for Types 0Z4, 5X4, 5Y4, 6AX5,
6X5

S-5018 1N1238

Maximum Ratings:

Peak Inverse Voltage
per Section1600 Volts Max.
Peak Rectifier Current
per Section8000 MA Max.
DC Output Current750 MA Max.
Ambient Temperature100°C Max.

Dimensions:

A—1-3/16" O.D. B—2-19/32" C—3-5/32"
Octal base
Replacement for Types 5AU4, 5AW4, 5AZ4,
5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4

S-5019 1N1239

Maximum Ratings:

Peak Inverse Voltage
per Section2800 Volts Max.
Peak Rectifier Current
per Section5000 MA Max.
DC Output Current500 MA Max.
Ambient Temperature100°C Max.

Dimensions:

A—1-5/16" O.D. B—3-3/4" C—4-5/16"
Octal Base
Replacement for Type 5R4

Send for data sheets on any of the above types.

**Sarkes
Tarzian**
INC.

RECTIFIER DIVISION

DEPT. EE-3, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGERS 2-7535

EXPORT: AD AURIEMA, INC., NEW YORK CITY

CIRCLE 239 ON READER-SERVICE CARD

New Products

Events Timer Five Place Accuracy



Model WT-1 wave timer measures electrical signals from one event per sec to 500,000 per sec with five-place accuracy. It may be used as an events-per-unit-time meter. Preset count capacity is up to 9999 and the precision timer range extends up to 1 sec in increments of 100 μ sec. The instrument is designed to operate with a minimum input pulse of 5 v or a minimum sine wave signal of 10 v. Input impedance is 10 K and power requirement is 20 w.

Ranson Research, Dept. ED, 323 W. 7th St., San Pedro, Calif.

CIRCLE 240 ON READER-SERVICE CARD

FM Signal Generator 440 to 580 Mc



Model 210-G fm signal generator covers the range from 440 to 480 mc. Equipped with mechanical and electronic vernier tuning, the generator is designed for broadcast fm receiver measurements as well as mobile radio systems. It features the bolometer bridge method of continuously measuring output voltage. Other applications include research and development of multiplexing and telemetering fm equipment.

Measurements Corp., Dept. ED, Boonton, New Jersey.

CIRCLE 241 ON READER-SERVICE CARD

THE SIZE 15 TELESYN[®] RESOLVER

from FORD INSTRUMENT



- Extremely accurate computing unit
- Resolves input voltages into sine and cosine components
- Miniature size
- Lightweight
- Rated 1-24 volts, 400 cps input.

The FICo Size 15 *Telesyn* Resolver is available in models with transformation ratios of 1:1, 4:1 and 8:1. It is widely applicable in such units as analog computers, angle data transmission systems, and similar equipment. Call or wire W. Mohr at our Component Sales Division in Long Island City, New York (STillwell 4-9000, ext. 654) for prices, or fill in and mail coupon below. Our FREE booklet on FICo's Size 15 Resolver line will be mailed to you as soon as we receive the filled-in coupon.

FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORP.

W. MOHR
Ford Instrument Co.
Component Sales Division ED
31-10 Thomson Ave., Long Island City, N.Y.

Please send me your data
bulletin on the Size 15
Telesyn Resolver.

Name _____
Position _____
Company _____
Street _____
City _____ State _____

CIRCLE 242 ON READER-SERVICE CARD

Side Indicating Meters Watertight Version



Two watertight versions of the large side indicator panel meter have been announced. Models 1146 and 1147 have a 2.7-in. scale arc equivalent to the ASA specification for conventional 1 1/2 in. meters. Initial accuracy is held to ± 2 per cent of full scale deflection for dc ranges.

International Instruments Inc., Dept. ED, New Haven, Conn.

CIRCLE 243 ON READER-SERVICE CARD

Dielectric Coolant Hose Contains No Metal



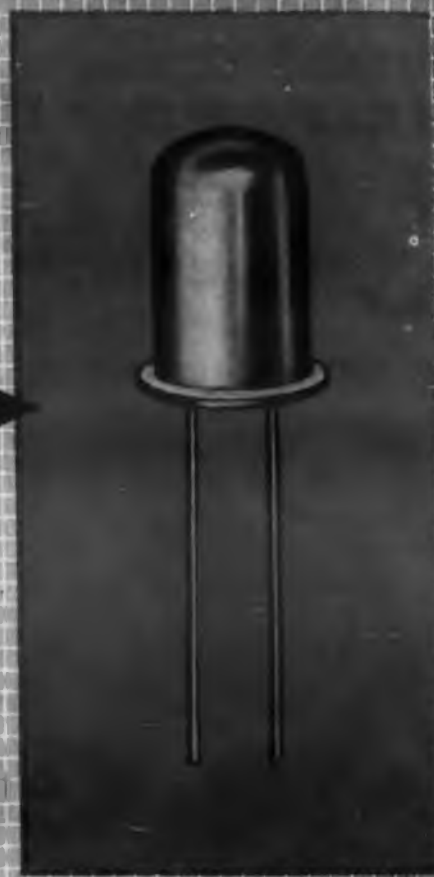
This type of chemically unaffected high temperature hose is specially designed for dielectric coolant use in magnetrons and klystrons. Corrosion-proof, non-swelling, and non-contaminating, Fluoroflex-T R536 hose is for high temperature use. Containing no metal, it combines high voltage insulation, protection against corona and moisture absorption, flex-life, and vibration resistance. Other applications include generators and high power transformers.

Resistoflex Corp., Dept. ED, Roseland, N.J.

CIRCLE 244 ON READER-SERVICE CARD

CIRCLE 245 ON READER-SERVICE CARD

*precise
voltage
regulation!*



U.S. SEMCOR

SILICON ZENER DIODES

for immediate delivery in singles, pairs, matched sets . . .



Now in atmospheric conditioned high volume production, U. S. Semcor's silicon ZENER DIODES provide low backward current with abrupt breakdown . . . give precise voltage reference at high temperatures for Voltage Regulation Circuits . . . may be combined to match any given parameters. Nominal Ratings from 3.9 to 560 Volts . . . 10% Tolerance. Singles, Pairs, Quads . . . *Close Tolerance Sets and Special Packages to Order.*

ORDER SAMPLE UNITS NOW!

We invite your evaluation of our precision manufactured units

U. S. Semiconductor Products Inc. is managed by the originators of the first production silicon ZENER DIODES, and is augmented by an engineering and research staff with 42 years of pinpointed experience.

Our field Engineering Representatives welcome the opportunity to consult with you on standard or special ZENER DIODE requirements. For address of office nearest you—or for complete technical data—WRITE TODAY to Sales Engineering Dept., U. S. Semiconductor Products, Inc., 3536 West Osborn Road, Phoenix, Arizona.

SEMCOR

U. S. SEMICONDUCTOR PRODUCTS, INC.

3536 WEST OSBORN ROAD • PHOENIX, ARIZ. • Appellate 8-5591

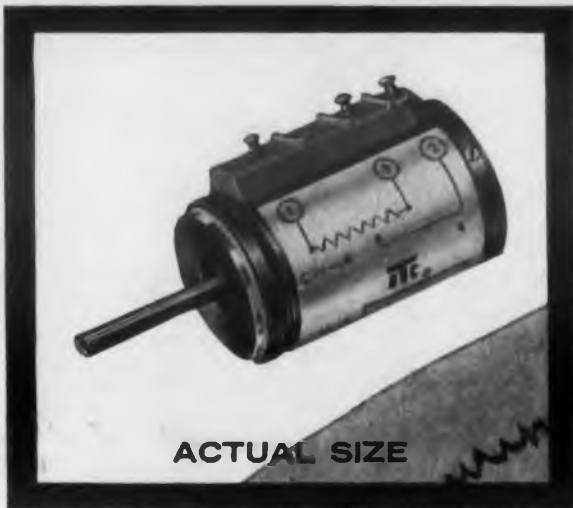
READY FOR DELIVERY

TIC *miniature multiturn potentiometer*

LINEARITY .05%

THE PERFECT COMBINATION

OF MINIATURIZATION, PRECISION AND STABILITY...



ACTUAL SIZE

... the M10T09 multiturn precision potentiometer is especially designed for applications in confined areas where the unit has to be small and yet there can be no loss of precision or reliability — applications such as aircraft, missiles, computers, etc.

The TIC M10T09 has a precision machined aluminum base and is impervious to shock and severe environmental conditions. Extraordinary electrical accuracy combined with mechanical precision produce inherent stability. New advanced design of the resistance element and precious-metal wiper and contacts provide long life with minimum change in linearity and noise characteristics.

The new TIC M10T09 multiturn potentiometer is now in full production and ready for delivery. This latest addition to the TIC line of precision miniature potentiometers incorporates only the very best materials, unique new methods of design and advanced production techniques to yield excellent linearities. It is an entirely new concept in precision miniature potentiometers.

Designed to meet the most exacting military and commercial specifications, this ten-turn potentiometer is extremely versatile. It provides high resolution in a range from 1000 ohms to 100,000 ohms and operates at temperatures from -55°C to $+130^{\circ}\text{C}$.

Type M10T09 is the result of TIC's constant research and development program. It is another step forward in setting the highest standards in the precision miniature potentiometer field.

Complete specifications on the new M10T09 are available on request.

TIC TECHNOLOGY INSTRUMENT CORP.

555 MAIN STREET, ACTON, MASS.

CIRCLE 246 ON READER-SERVICE CARD

New Products

Analog-Digital Converter Precise Data Processing



Type 525 Encoder is designed to provide precise and dependable conversion of analog input data to digital output voltages. Emphasis is placed upon accuracy and resolution. The unit is designed as a companion piece to the Model 1002 Decoder for telemetering and other data processing applications.

Avion Div. AFC Industries, Inc., Dept. ED,
800 N. Pitt St., Alexandria, Va.

CIRCLE 247 ON READER-SERVICE CARD

Production Testing Unit Accurate Limit Control



This contact-making control system consists of a reference standard edgewise panel indicating instrument and a thyatron-relay control unit. All instruments conform to A.S.A. specifications for 0.25 per cent and 0.5 per cent portable secondary standards. The control unit is basically a thyatron, which fires upon closing of the meter contacts, thus actuating a relay. Operation is ac, dc, or both. The unit will measure almost any quantity which can be indicated electrically.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N.Y.

CIRCLE 248 ON READER-SERVICE CARD

Miniature Indicator Lamps Assembled in Decade Strips

The Litestrip is essentially a preassembled and pre-tested strip of ten indicator lamps bearing numerals from zero to nine. The unit thus forms a complete decade ready for assembly into computers, matrix, and read-out applications at a

HIGH VOLTAGE BREAKDOWN TEST

*... proves
Johnson tube sockets
are built to take it!*

**Eliminate special set-up charges!
Pick the tube socket you need from
Johnson's 3 basic grades . . .**

STANDARD—These are commercial grade sockets for general requirements. Bayonet Sockets equipped with porcelain bases, glazed top and sides. Phosphor bronze contacts .0002 cadmium plated. Nickel-plated hardware. Bayonet shells are etched aluminum. Wafer Sockets equipped with glazed steatite base—DC200 treated. Contacts are plated brass with steel springs. Shielded types equipped with etched aluminum shields.

INDUSTRIAL—Superior in quality to "Standard" types, equipped with glazed steatite bases, DC200 treated. Phosphor bronze or beryllium copper contacts and springs, .0005 silver-plated. Fungus resistant cushion washers under contacts. Aluminum bayonet shells and shields for wafer types, iridite No. 14 treated.

MILITARY—Top quality for military requirements. Glazed L4 steatite bases, DC200 treated. Bayonet Sockets equipped with beryllium copper contacts .0005 silver-plated. Hot tin-dipped solder terminals—brass bayonet shells, .0003 nickel-plated. Threaded hardware .0002 nickel-plated—unthreaded hardware .0003. With fungus resistant cushion washers under contacts. Wafer Sockets equipped with phosphor bronze contacts and beryllium copper springs, silver-plated .001. Hot tin-dipped solder terminals. Fungus resistant, glass base melamine cushion washers under contacts. Aluminum shields on shielded types, No. 14 iridite treated. Entire socket protected for 200 hour salt spray test.

Complete specifications . . .
Write for your copy of
Socket Standardization
Booklet 536, today!



E. F. Johnson Company

3415 Second Ave. S.W. • Waseca, Minnesota

CIRCLE 249 ON READER-SERVICE CARD

LOW NOISE

AC AMPLIFIER

selectable bandwidths
and a 400 megohm, 3 mmf input

VERSATILITY teams up with high input impedance in this new, improved broad-band amplifier. Used as a general purpose preamplifier or as an isolation amplifier, it fits neatly in scores of tests at both audio and ultrasonic frequencies.



KEITHLEY
MODEL 102B
ISOLATION
AMPLIFIER

TYPICAL applications are: vibration and noise studies, work with accelerometers and hearing aids, and pulse amplification. A 50-volt 50-ohm output is provided for driving oscilloscopes, sound level meters, and recorder power amplifiers.

FEATURES of the Model 102B are: accurate decade gains of 0.1 to 1000; selectable bandwidths of 2 cps to 150 kc or to 1.7 mc; noise below 10 microvolts with 150 kc response, and below 20 microvolts with 1.7 mc response.

Two very low capacitance input probes are available: 5 mmf, 2 cps to 150 kc response; and 20 mmf, 2 cps to 1.7 mc response.

NEW CATALOG gives detailed data on the Model 102B and all other Keithley instruments and accessories. Your copy will be sent promptly upon request on your company letterhead.



KEITHLEY
INSTRUMENTS, INC.
12175 Euclid Ave., Cleveland 6, Ohio

CIRCLE 250 ON READER-SERVICE CARD

cost less than that of installing individual lamps. A standard decade Litestrip measures 1/2 x 1 x 6 in. Litestrips are available with incandescent lamps for operation from 1.3 to 28 v and with the NE2C subminiature neon lamp for on higher voltages. Current drawn is extremely low.

Circon Component Corp., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

CIRCLE 251 ON READER-SERVICE CARD

Panel Meter Saves Space



Known as the Model 1135, this meter has a 2-1/8 in. scale length- comparable to that of a 3-1/2 in. round or square meter- but occupies much less of the panel area. Accuracy is held to ± 2 per cent of full scale deflection for dc applications and ± 5 per cent for ac. The meters may be mounted horizontally or vertically, and are suitable for dual back-to-back mounting to facilitate comparative readings.

International Instruments, Inc., Dept. ED, P.O. Box 2954, New Haven 15, Conn.

CIRCLE 252 ON READER-SERVICE CARD



Digital Indicator Coincidence Type

This motor driven digital indicator operates on a direct wire basis and is not a stepping switch as it contains no ratchet pawl mechanism. The indicator does not count to position but searches for coincidence. The indicator responds to binary code, and the prototype operates on a four wire basis, where the binary condition is satisfied by the presence or absence of direct current voltages on the four leads. The coded decimal notation was chosen for the prototype, but other notations such as octal or hexadecimal present no problem in application. Power consumption is less than 3w.

Union Switch & Signal, Div. of Westinghouse Air Brake Co., Dept. ED, Swissvale, Pa.

CIRCLE 253 ON READER-SERVICE CARD

BULOVA

FAMED FOR PRECISION SINCE 1875



CRYSTAL FILTERS



Precision engineered multiple-crystal filters are now available as packaged units from one of the world's foremost manufacturers of quality crystals.

By being able to maintain exacting control of individual crystal characteristics, during manufacture, Bulova can quickly and economically produce precision crystal filters on a custom design or production basis.

TELEMETRY: Many telemetry centers are now relying on Bulova filters to preserve the accuracy of multiplexed data during processing. Wide band and narrow band filters are available.

SINGLE SIDE BAND: For voice and other ssb applications Bulova filters provide excellent suppression of unwanted side band in both transmitting and receiving equipment.

Center frequencies from 10 KC to 20 MC, with bandwidths of .01%-8% of center frequency can be provided in either symmetrical or asymmetrical filters using Bulova high precision crystals.

Send for literature on Bulova's standard and custom design filters today, or let our engineering staff study your filter problem and recommend a suitable package for your particular application.



BULOVA

w a t c h c o m p a n y

Electronics Division
Woodside 77, N. Y.

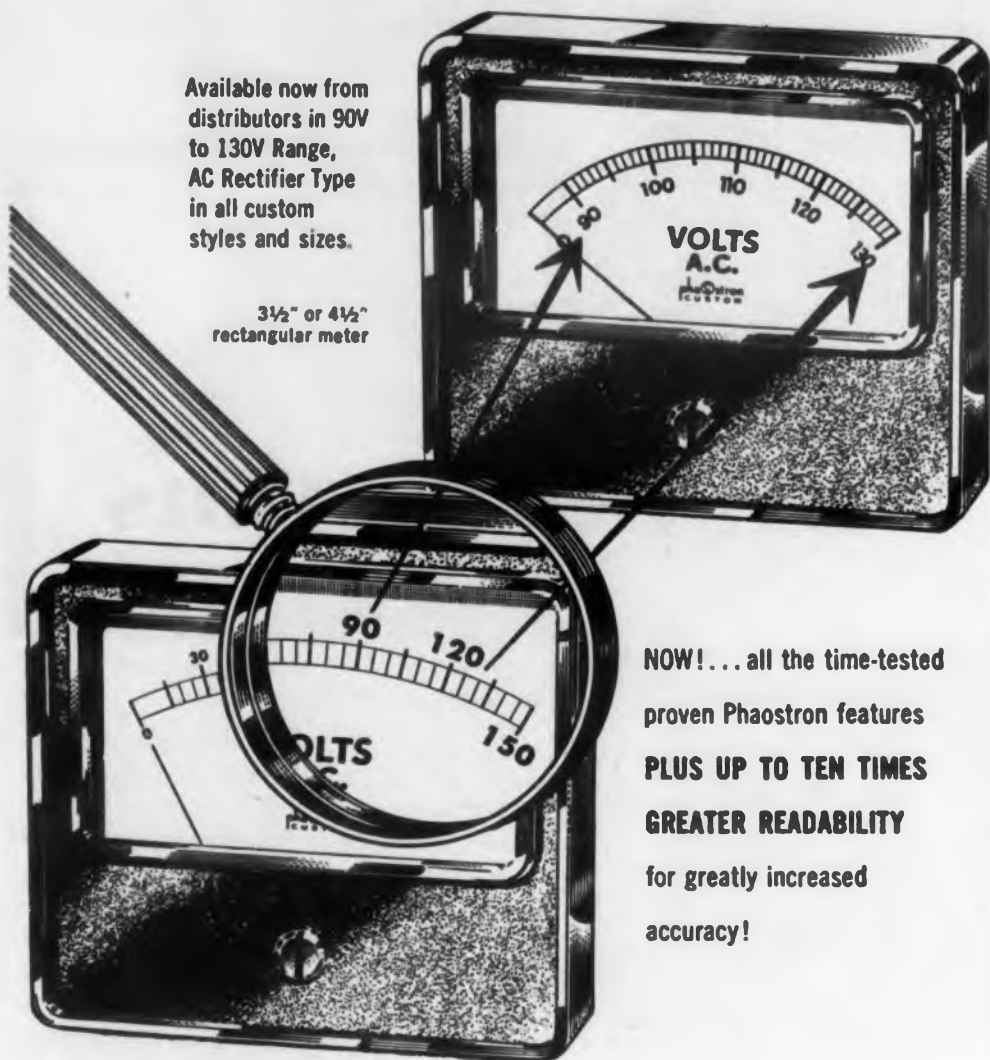
Write Dept. A-848 For
Full Information and
Prices on Crystal Filters

CIRCLE 254 ON READER-SERVICE CARD

NEW PHAOSTRON EXPANDED SCALE AC Voltmeter

Available now from distributors in 90V to 130V Range, AC Rectifier Type in all custom styles and sizes.

3½" or 4½" rectangular meter



NOW!... all the time-tested proven Phaostron features PLUS UP TO TEN TIMES GREATER READABILITY for greatly increased accuracy!

2½" or 3½" square meter



6" rectangular meter



2½" or 3½" round meter

Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most—between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range—linearity—true rms reading and Phaostron craftsman construction.

Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms, are available in nine types at your Parts Distributor. For special requirements for AC or DC expanded scale meters, write to Product Development Dept. for practical recommendations.

All meters available with illuminated dial on special order

PHAOSTRON

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.
CIRCLE 255 ON READER-SERVICE CARD

New Products



Selenium Rectifier
Replacement for 6AL5

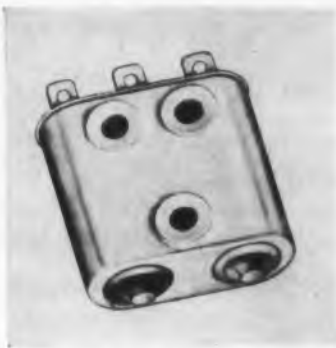
Model SE51K4D883 is designed to replace the 6AL5 vacuum tube in tv circuits where the peak inverse voltage does not exceed 40 v. Primary advantages of the unit over the tube are that it has longer service life, and will withstand current surges as high as 80 ma. Specifications for the unit are: maximum applied voltage of 26 v rms; maximum dc output voltage of 20 v; peak inverse voltage of 40 v. Rectifier plates are encapsulated in a molded phenolic housing whose low coefficient of expansion resists effects of changing temperatures.

Bradley Laboratories, Dept. ED, New Haven, Conn.

CIRCLE 256 ON READER-SERVICE CARD

Sealed Switch

Unaffected by Ambient Pressures



Although hermetically sealed, actuation of these switches is not affected by high ambient pressures. A balancing system automatically equalizes environmental pressures on the actuating mechanism, so that the actuation force remains the same, regardless of surrounding pressure or vacuum. Switches can be furnished with an actuation force of either 10 oz or 32 oz max. The design can be applied to miniature switches of various electrical ratings, and a seal can be furnished which is impervious to the deteriorating effects of immersion in corrosive liquids like JP-4 fuel.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

CIRCLE 257 ON READER-SERVICE CARD



When you specify
CONNECTORS

specify
Automatic

Highest standards of quality. Modern high speed automatic machinery, and up-to-date production procedures, based on over 15 years experience in the manufacture of precision parts for the Army, Navy, Air Force and Atomic Energy Commission.

More and more companies in the electronics and telecommunications industries are specifying "Automatic's Connectors."

Our engineers are always ready to discuss your special requirements.

Manufacturers of

RF FITTINGS • RF CONNECTORS
COAXIAL RELAYS • COAXIAL SWITCHES
COAXIAL CABLE ASSEMBLIES • DIRECTIONAL COUPLERS • INSULATED CONNECTING RODS AND SHAFTS • POWER PLUGS • AUDIO PLUGS • BAYONET LOCK AND PUSH ON SUB-MIN CONNECTORS

WRITE, WIRE OR PHONE FOR FURTHER INFORMATION.

Automatic
METAL PRODUCTS CORP.

319 Berry Street
Brooklyn 11, N.Y. • EVERgreen 8-0364

CIRCLE 258 ON READER-SERVICE CARD



TO DESIGN ENGINEERS
WITH A SPACE
AND WEIGHT PROBLEM

**transistorized
electronic filter
regulator
and decoupler**

If your design problem involves a light weight, rugged unit for use with 24 to 28 volt d.c. systems, your answer lies in Transistor Devices, Inc.'s electronic filter. It completely replaces the iron-core component-type filter . . . has a 99% reduction in ripple, peak to peak . . . will consistently regulate load and line to ± 10 millivolts . . . has an internal resistance of only 8 ohms . . . inserts easily between generator and load . . . sells for a low \$55.*

Write today for the Transistor Devices, Inc. catalog, including complete information on this and other TDI power supplies.

*quantity discounts on request

SPECIFICATIONS

Input	24 to 28 volts d.c.
Output	20 volts (adjustable 0 to .5 ampere)
Ripple Reduction	100 to 1 at worst point
Load Regulation	± 10 millivolts
Line Regulation	± 10 millivolts
Approx. Size	40 cu. in.
Approx. Weight	2 lbs.
Output Impedance	1 ohm 0 to 20 kc

**TDI
TRANSISTOR
DEVICES,
INC.**

730 Boulevard, Kenilworth, N. J.

CIRCLE 259 ON READER-SERVICE CARD

On-Off Recorder

Accepts 100 Channels



This event recorder instantly and simultaneously records up to 100 channels of on-off information in permanent chart record form. The instrument indicates the events, the duration of events and their correlation with other events as a function of time. The instrument is suited for checking sequences in missile and aircraft control systems, time coding, evaluating telephonic communications systems, and checking relay chatter and contact-bounce. On-off signals as short as 0.001 sec can be recorded.

Brush Instruments, Div. of Clevite Corp., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

CIRCLE 260 ON READER-SERVICE CARD



Klystron Transmitter

1 KW of CW Power

The model 74T transmitter produces 1 kw of cw power over the band 1700 to 2400 mc. It utilizes an 3K2500SG klystron with a power gain of 25 db. The transmitter consists of a beam-power supply, focus-electrode supply, klystron-filament supply, three focus-magnet supplies, and all required controls, meters, interlocks, indicators, etc. to comprise a complete system. Incidental fm is below 5 cps. With proper modulation of the r-f drive, the unit is capable of am, fm, fsk, or ssb modulation. The equipment requires about 10 kva of power from a 208-v, 3-phase, 4-wire, 60-cps source.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 261 ON READER-SERVICE CARD

Do YOU Seek Definite Improvement in...



Evacuation of Lighting, TV or Radio Tubes



Purification of Germanium, Selenium and Silicon... and Crystal Growing



Vacuum Curing of Transistors, Diodes and other Semi-Conductors



Purification of Metals under Vacuum



Vacuum Impregnation of Condensers, Transformers, Windings, Cables, etc.



Vacuum Metallizing and Metal Evaporating

Kinney[®]

HIGH VACUUM



for work in the low micron region

KINNEY Simplex and Duplex Single-Stage Oil Sealed Mechanical Pumps afford a choice of 9 models with displacements from 13 to 780 cfm and ultimate pressures to 10 microns (McLeod). Compound Pumps in 4 sizes - 2.0 to 46.0 cfm - develop ultimate pressures to 0.2 micron (McLeod).



for high pumping speed in the low micron region

KINNEY Mechanical Booster Pumps in 4 models with displacements from 30 to 5000 cfm. These revolutionary Pumps produce a clean, dry vacuum in the 0.2 micron (McLeod) range or better without use of cold traps or baffles. Widely used in metallurgical and electronic work.



for metallizing and laboratory evaporation work

KINNEY complete High Vacuum Systems embrace a comprehensive selection of Evaporators, Furnaces, Curing Ovens, High Vacuum Pumping Systems and Power Units. KINNEY-built equipment reflects the know-how of extra years of experience in High Vacuum technology.



Write for bulletins on new developments in KINNEY Pumps and High Vacuum Systems.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY

3561L WASHINGTON STREET • BOSTON 30 • MASS



Please send me literature on

- KINNEY High Vacuum Pumps
 KINNEY High Vacuum Systems

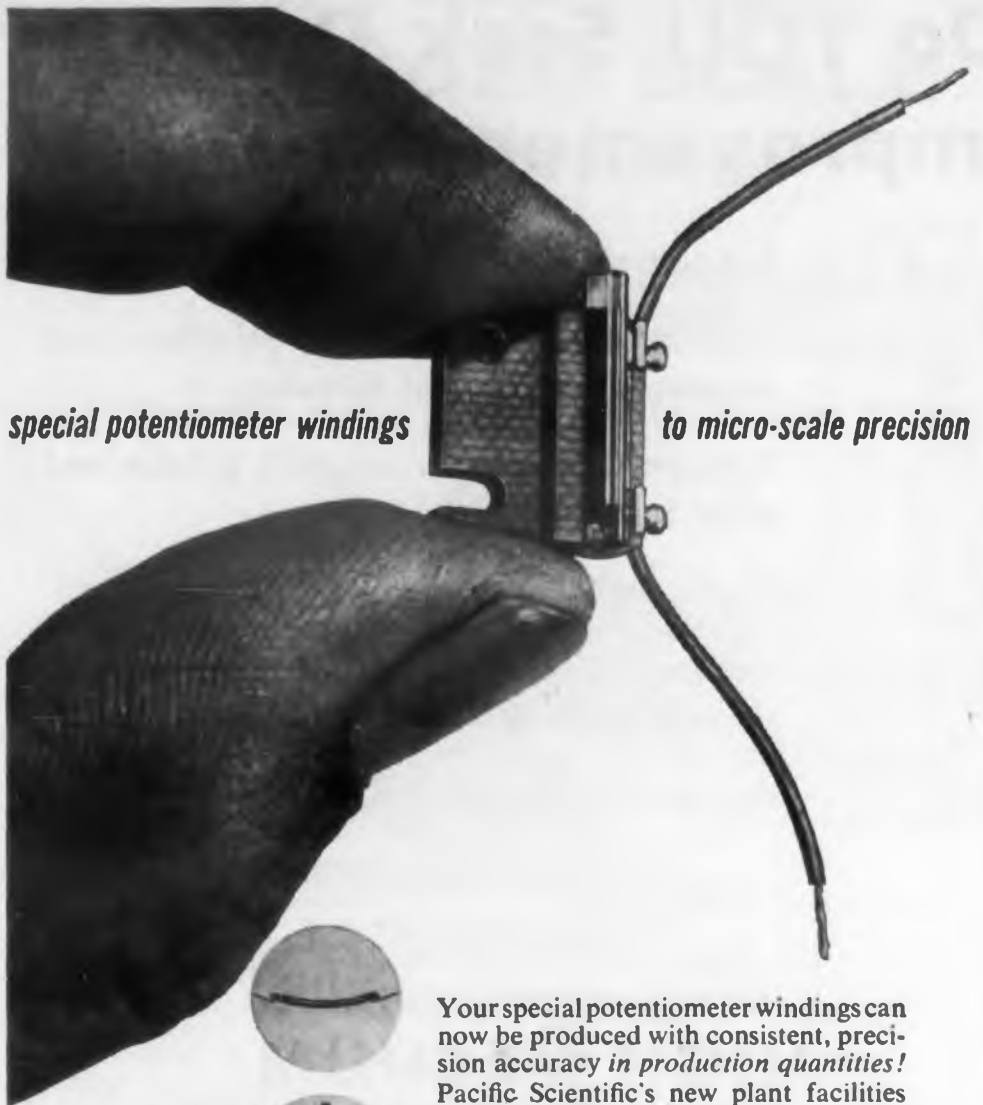
Name _____

Company _____

Address _____

City _____ Zone _____ State _____

CIRCLE 262 ON READER-SERVICE CARD



special potentiometer windings

to micro-scale precision



Your special potentiometer windings can now be produced with consistent, precision accuracy *in production quantities!*

Pacific Scientific's new plant facilities and specially designed microscopic winding equipment can now provide extremely close linearity tolerances on your special designs whether standard or sub-miniature, and in unusual configurations. Elements are wound to your own specifications on glass, Formvar-covered copper or aluminum mandrels, and X-Y recorder inspection assures uniformity of quality.

Pacific's engineering department can also help solve your special problems . . . and complete environmental facilities are available to test to the most rigid military specifications.

Call or write Pacific for engineering assistance on your special potentiometer problems — today!

complete potentiometers

Pacific also designs and builds complete potentiometers — both rotary and linear motion — to suit your requirements.



SPECIAL MICRO-WINDING EQUIPMENT FOR CONSISTENT ACCURACY



PACIFIC SCIENTIFIC COMPANY

P.O. Box 22019, Los Angeles 22, California
 San Francisco • Seattle • Arlington, Texas • San Diego
 REPRESENTATIVES - Eastern U.S.: Aero Engineering
 Company • Canada: Garrett Manufacturing Corp.

CIRCLE 263 ON READER-SERVICE CARD

New Literature

Decimal Equivalents

264

Easy readability was the aim in designing a 16 x 23 in., 3-color wall chart of decimal equivalents. Separated into 2 columns providing ample space for large-size numbers, the chart contains guide lines that join each decimal with its equivalent fraction for instantaneous conversion. Decimals, carried to 4 places, run down the center of each column with 64ths to the right, 32nds and 16ths to the left, in staggered formation. John Hassall, Inc., Westbury, N.Y.

Plastic Sheets, Rods, Tubes

265

Teflon, Nylon, Kel-F, phenolics, and Plexiglas in sheets, rods and tubes are described in general catalog now released. The stock materials include vinylite, acetate, polystyrene, and polyethylene in all sizes. Allied Plastics Supply Corp., 75 Cliff St., New York, N.Y.

Phasemeter

266

Bulletin on recently developed Model PM-1B Phasemeter is now available. This bulletin describes in detail the specifications and applications of the phasemeter as well as significant features. Also contains illustrations and a diagram of the new unit. Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.

Silicone Molding Compounds

267

A 4-page, 3-color brochure now available is exclusively devoted to silicone molding compounds. Illustrated with charts, graphs and photos, it outlines such features as low thermal conductivity, superior electrical properties, and high temperature strength-to-weight ratio of these materials. Types MSI-30 and MSG, designed to meet MIL-M-14E, are discussed in relation to their physical and electrical properties. Dow Corning Corp., Midland, Mich.

NEW cathode ray indicator by TECHNITROL



The Technitrol Cathode Ray Tube indicator provides a visual indicating device for the dynamic display of electrical signals. It is intended primarily as an output indicating device for such instruments as the Technitrol Dynamic Diode Tester and transistor curve tracers, no internal sweep circuits being provided.

This new indicator makes an excellent display unit for analogue computer and other applications where the repetitive

cycle rate of the display is consistent with screen persistences of available five-inch cathode ray tubes.

High-quality, conservatively-rated components assure a stable instrument which provides a very sharp focused beam on the face of the cathode ray tube.

Designed for standard 19" relay rack mounting, separate mounting legs are available at small additional cost.

- Equipped with identical high-gain DC-coupled amplifiers on both axes.
- Amplifier band widths: 3 db down at 110 kc; 6db down at 200 kc.
- Sensitivity: 7 millivolts rms per cm on horizontal channel; 5 millivolts per cm on vertical.
- Amplifiers provided with either single-ended or balanced inputs.



MANUFACTURERS OF PULSE TRANSFORMERS, DELAY LINES AND ELECTRONIC TEST EQUIPMENT
CIRCLE 268 ON READER-SERVICE CARD

Strain Reliefs

269

Three standard strain reliefs—all metal, click-on, and insulated—are displayed in a 4-page pamphlet. For each type there is a description, a list of available sizes and pictures which illustrate the device and its insertion. Wire binding sleeves are also shown. George Walker Co., Passaic, N.J.

"Woik!"

270

The history of this "art masterpiece" is amusingly presented in Helinews No. 17. The six page house journal also presents information on a new series of conductive-glass film trimming potentiometers and an electromechanical breadboard kit. Beckman/Helipot Corp., Newport Beach, Calif.

Terminal Blocks

271

Terminal Blocks, catalog folder No. SB 160 now available describes the complete line of heavy duty "controlead" terminal blocks. Includes illustrations of each type with series number and specifications. Marathon Electric Mfg Co., Wausau, Wis.

Infrared Optics

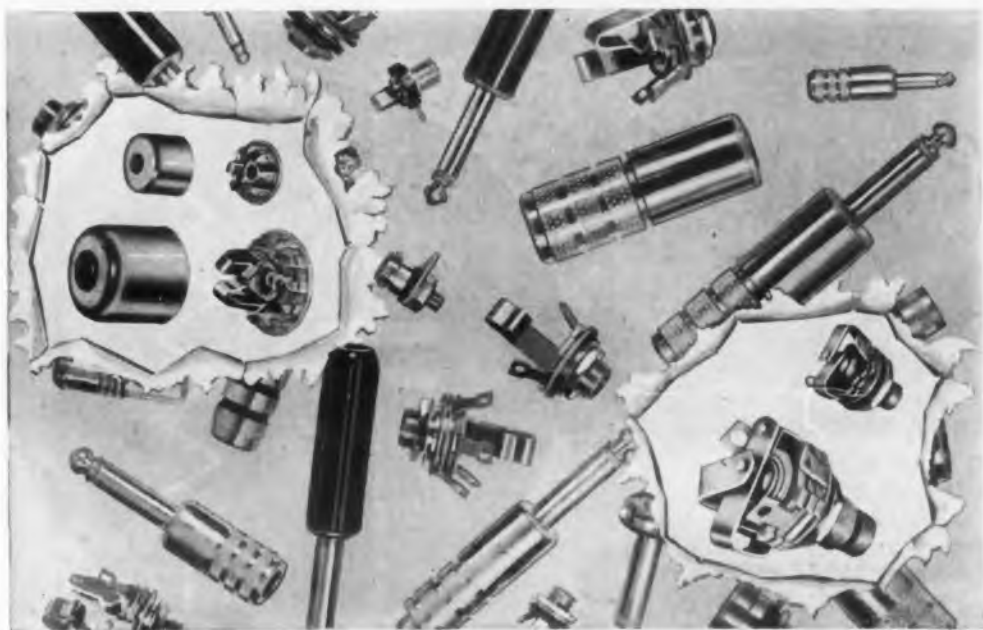
272

Infrared optical systems—reflective, refractive and combinations of the two are discussed in 4-page brochure now released. Some of the problems of selecting a material for any infrared application and the various factors taken into consideration are described in this brochure entitled "Infrared Systems Are Design Problems." Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Pk., N.Y.

Ceramic Magnets

273

High coercive force permanent magnets that are molded from low cost ceramic powders are shown in 12-page bulletin now released. Recently revised, the Bulletin RC-11A includes many helpful diagrams and illustrations of specific Ceramagnet uses and their advantages for various mechanical, electrical and electronic applications. Also included are ten graphs plotting every magnetic characteristic of importance to design engineers. Stackpole Carbon Co., St. Marys, Pa.



TWO NEW **ELECTROCRAFT**® COMPONENTS

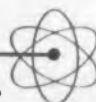
SHIELDED JACKS . . . for effective shielding of high impedance circuits. Shield and cover cadmium plated steel. Made in open and closed circuits . . . miniatures in 2 conductor . . . standards in all circuits, 2 & 3 conductor.

PUSH BUTTON SWITCHES . . . for momentary contacts. Miniature for low level circuits only. Standard sizes in 2 ratings—integral contacts for low level circuits . . . fine silver for 3 amp 115v. Write for Catalog.

ELECTROCRAFT®

Richards Electrocraft, Inc.

3755 N. KEDZIE AVENUE, CHICAGO 18, ILLINOIS



CIRCLE 274 ON READER-SERVICE CARD

ENGINEER OPPORTUNITIES AT RAYTHEON



NEW C.A.A. RADAR being developed at Wayland Lab will be used in nationwide aircraft surveillance network. Features: video mapping converter, circular polarizer, complete system remote controls available at the console.

Wayland Laboratory's "dream" facilities and projects gain national reputation

Ask any development engineer who's visited Raytheon's Wayland Laboratory! He'll tell you it's one of the most modern labs for prototype development of electronic equipment and that Wayland projects are the most advanced in their respective fields.

There are four creative departments:

COMMUNICATIONS – scatter, radio relay, T.V. terminal and message circuit multiplex equipment.

COUNTERMEASURES – radar countermeasures equipment, advanced countermeasures systems and techniques study.

RADAR – pulse radar equipment including ground-based, airborne, long range search, air traffic control, weather and commercial marine.

SONAR – submarine, ship and airborne sonar equipment.

PLUS TWO OTHER DEPARTMENTS providing engineering services . . . *environmental test, reliability and components engineering, engineering standards, production engineering, and technical writing.*

For details, please contact Donald B. Stillman, Staff Assistant to Manager, Box 11D, Wayland Laboratory, Wayland, Mass.

RAYTHEON MANUFACTURING COMPANY
Wayland, Massachusetts

Are you the
ONE MAN IN THREE?



WAYLAND LABORATORY

Excellence in Electronics

Continued

BIG-POT PERFORMANCE in Miniature-pot size

Waters ROTARY TRIMMER POTENTIOMETERS

are built, tested and certified* to rigid military environmental specifications and are available in many variations: ganged, tapped, with various electrical and mechanical angles, locking shafts, anti-rotation pins, "O" rings, custom shafts, and with the new Waters concentric shaft construction that provides two pots on a single mounting, with two separate controls. *Complete data on request.

NOW! A complete single turn pot line
from Waters

CHECK THESE SPECIFICATIONS

Model	Resistance Range (ohms)	Standard linearity †	Case Dia. (inches)	Standard Shaft Dia. (inches)
AP 1/2	1/2 to 250 K	5% ‡	1/2	1/8
RT/RTS 7/8	1/2 to 250 K	3%	7/8	1/8 · RTS 1/4
AP 1 1/16	1/2 to 350 K	2%	1 1/16	1/8
AP 1 1/8	1/2 to 350 K	2%	1 1/8	1/4
AP 1 5/8	1/2 to 500 K	1%	1 5/8	1/4

† For best possible linearity, submit detailed specifications. ‡ 2% over 50K

Bushing-mount standard. Servo and 3 hole mounting available.

Bushing for 1/8" dia. shaft is 1/4-32 by 1/4" long

Bushing for 1/4" dia. shaft is 3/8-32 by 3/8" long.

Standard resistances — all series: 50, 100, 200, 500, 1K, 2K, 5K, 10K, 20K and 25K. 40K and 50K also on RT/RTS 7/8; 40K, 50K, and 100K on AP 1 1/16, AP 1 1/8, and AP 1 5/8 series.

The most compact half-inch pot on the market.

A dependable micro-miniature trimmer pot available with axial or radial terminals, in ganged units or in a special printed-circuit model.



TYPE
AP 1/2

An efficient, accurate, miniature trimmer pot for military and commercial installations that demand the most dependable components. Available with bushing or servo mount, or with concentric-shaft construction.



TYPE
RT 7/8

NEW A new addition to the Waters line, providing a reliable precision unit in the AIA nominal one-inch size. Available with bushing or servo mount. Non-linear design possible.



TYPE
AP 1-1/16

An old standby — providing higher resistance, better resolution and linearity but in miniature size. Available with bushing or servo mount, and with concentric shaft construction.



TYPE
AP 1-1/8

NEW Provides big-pot precision and reliability in a standard size unit by application of Waters miniature-pot design and assembly techniques. Ideal for non-linear applications.



TYPE
AP 1-5/8

Write for catalog of the Waters complete single-turn pot line; *precision, trimmer, low-torque, miniature.*

Waters
MANUFACTURING, inc.

APPLICATION ENGINEERING OFFICES
IN PRINCIPAL CITIES

Wayland, Massachusetts



CIRCLE 276 ON READER-SERVICE CARD

New Literature

Advantages of Flexograin 277

Why Flexograin is better suited for many uses than the coarser-grained phosphor bronze is the theme of a technical bulletin, T-4. Besides containing microscopic photographs that demonstrate the advantages of this fine-grain phosphor bronze, the 4-page bulletin also presents graphic illustrations of various applications. H. K. Porter Co., Inc., Riverside-Alloy Metal Div., 300 Park Ave., New York 22, N.Y.

High Performance Transducers 278

"Airborne Components" is a 56-page catalog containing information on high performance transducers. Instrument sections discuss: accelerometers, pressure transducers, gyros, temperature probes and vane transducers. Also included is a technical section comprising previously unpublished data. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

Operational Mixer 279

Developed for use in summing the outputs of up to 18 subcarrier oscillators, the Model 10022 operational mixer is presented in a recent 4-page brochure. Diagram-illustrated, the text discusses features and specifications of this 9 oz unit which measures 1-15/64 x 2-5/16 x 4-9/64 in. Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md.

Transistor Analyzer 280

A combination curve tracer and small signal dynamic analyzer, the BCT-300 transistor analyzer is the subject of discussion in Bulletin 387C. Keynotes of the four pages are specifications, applications, and operation characteristics. A photograph shows the functionally located operating controls; a block diagram describes the variety and flexibility of test functions. Norden-Ketay Corp., Commerce Rd., Stamford, Conn.



WIDE RANGE C and R BRIDGE

BRIEF SPECIFICATION

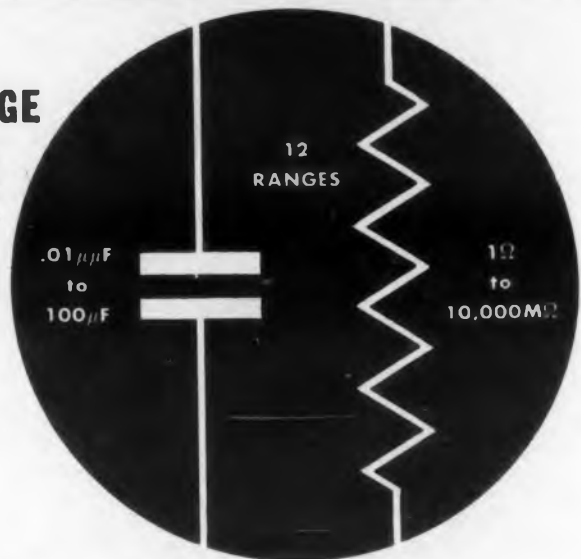
C .01 μ F to 100 μ F
R 1 Ω to 10,000 M Ω
Ranges 12
Accuracy $\pm 1\%$ on all ranges
Frequency 1592 c.p.s.

FEATURES

- Easy to operate — C & R dials balance independently.
- Built in oscillator and visual detector.
- Measures extremely small capacities without jigs.

PRICE \$655

DELIVERY IMMEDIATE



Exclusive Sales and Service in U.S.A.

MARCONI instruments
44 NEW STREET • NEW YORK 4, N. Y.

CIRCLE 281 ON READER-SERVICE CARD

Selector Switches 282

The key or push-button selector switches for thermocouple or resistance bulb circuits are shown in bulletin No. 24-1 now released. The bulletin describes in detail the various types of two- and three-position key switches and push-button switches. Individual diagrams illustrate how each type is incorporated in the circuit. Thermo Electric Co., Inc., Saddle Brook, N.J.

Contact Cleaner 283

Fourteen reasons why Cramolin is best suited for liquid electrical contact cleaning are stated in a 2-page data sheet recently released. Applicable as a cleaner, preservative, anti-corrosive as well as a lubricant for electrical contacts, Cramolin, according to this sheet, operates effectively between -40 and $+150$ C. Caig Labs., 46 Stanwood Rd., New Hyde Park, L.I., N.Y.

Stabilized DC Indicating Amps 284

Stabilized dc voltage and current indicating amps are described in 2-page data sheet ED7(1) now available. The sheet gives examples of applications such as output

measurement of strain gages, thermocouples, and phototubes. Complete specifications are listed for amps and operation is explained with aid of schematic diagrams. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Printed Circuit Soldering 285

The subject of solder, soldering fluxes and their application is presented in a recently-released technical bulletin entitled "Printed Circuit Soldering." Twelve pages in size, it describes the types of fluxes suitable for printed circuit soldering, outlining such matters as temperatures, procedures, alloys and contaminations. Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill.

Plastic Tubular Capacitor 286

Engineering Bulletin now available describes Type BTS, plastic tubular capacitor for printed circuits. These capacitors are keyed for automation assembly and are available in capacity ranges from 0.001 to 0.47 mfd, and voltage ranges from 200 to 600 v. The sizes of the units vary from $3/8 \times 1-3/8$ in. to $3/4 \times 1-7/8$ in. Pyramid Electric Co., 1445 Hudson Blvd., No. Bergen, N.J.

DIMCO-GRAY

SNAPSLIDE FASTENERS

**PROVIDE VIBRATION-PROOF HOLDING
AND QUICK, FOOL-PROOF RELEASE!**

APPROVED UNDER ARMY-NAVY STANDARDS

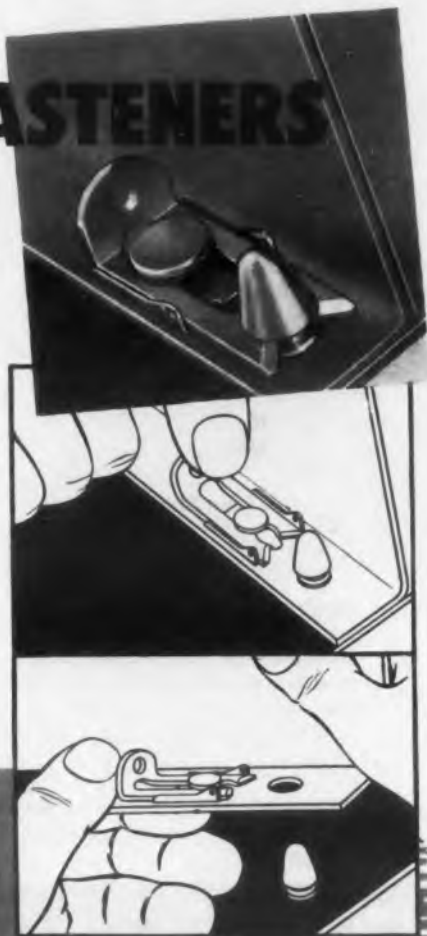
Here's a simple, easy means of securely fastening assemblies to withstand shock or vibration, and yet allow quick removal for inspection or repair. Instant snap action engages or releases fastener . . . no tools are required! After installation, fasteners never need adjustment . . . even with repeated use.

Three sizes available for different load requirements. Large and medium sizes are made of corrosion-resistant stainless steel. Small size is made of nickel-plated brass. Stock parts fit various thicknesses of flanges and mounting plates . . . special parts can also be supplied.

WRITE FOR FULL DETAILS TODAY!

DIMCO-GRAY COMPANY

201 E. SIXTH STREET DAYTON, OHIO
CIRCLE 287 ON READER-SERVICE CARD



ENGINEER OPPORTUNITIES AT RAYTHEON



DOPPLER NAVIGATION EQUIPMENT is readied for flight testing under operational conditions. Engineers at the Maynard Laboratory hold responsibility for program from initial study phase through prototype production.

Newly formed project groups solve complex airborne radar problems

Engineers like the project-type organization at Raytheon's Maynard Laboratory. It gives them maximum diversification in their work on the most advanced radar navigational and control problems of the day.

At Maynard, you'll find projects involving many areas of aircraft navigation and guidance systems . . . doppler navigation, velocity check systems, night-fighter operations systems, flight-control systems, altimeters. There is also interesting new work on counter-measures equipment.

Career opportunities for men at all levels now exist in the following areas:

**ADVANCED CIRCUIT DESIGN
ELECTRONIC PACKAGING
ANTENNA DESIGN
MICROWAVE COMPONENT
DESIGN**

**HEAT TRANSFER ENGINEERING
SPECIFICATIONS WRITING
TECHNICAL WRITING
SYSTEMS ANALYSIS &
ENGINEERING**

For complete details on engineering positions in any of Maynard's project groups, please write John J. Oliver, P.O. Box 87D, Raytheon Maynard Laboratory, Maynard, Mass.

RAYTHEON MANUFACTURING COMPANY
Maynard, Massachusetts

Are you the
ONE MAN IN THREE?



MAYNARD LABORATORY

Excellence in Electronics

Continued

now! 7-day delivery

on any 3 standard data printers

Now from Clary! Data printers delivered to you in a fraction of the usual time! Only Clary offers you 3 *standard* data-printing models with your choice of special dials and punctuation. Years of experience in this field have shown that these 3 standard models can be used in 85% of all data-printing applications...and at tremendous time and cost savings. Special built models are also available, if needed.



Model P-11
11-digit
parallel entry

Model P-8
8-digit
parallel entry

Model P-5
5 digit
parallel entry

*Write for
Engineering Folder S-101*



Manufacturer of Industry's most versatile data printers

ELECTRONICS DIVISION

Clary Corporation, San Gabriel, California

Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.

CIRCLE 289 ON READER-SERVICE CARD

New Literature

Infrared Developments 290

"Answer-Power" is a booklet which outlines infrared research and development done for industrial firms and government agencies. It briefly describes some typical nonclassified developments to show how problems can be solved for infrared and electronic industries. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

Hermetically Sealed Connectors 291

Publication of a brochure incorporating the latest information on AN type hermetically sealed connectors was recently announced. Assisted by charts, tables, diagrams, blueprints, and performance data, this 2-color brochure, PB-1, points out the applications for both standard and custom types. Hermetic Connector Corp., 483 Washington St., Newark, N.J.

Oil Filled Capacitors 292

Covered in Catalog 1180 are heavy duty industrial type oil capacitors. Designed specifically for continuous heavy duty industrial and electronic applications, these capacitors are available in rectangular, bathtub and tubular cases, in capacities up to 24 μ f and 6000 v. Industrial Condenser Corp., 3243-65 N. California Ave., Chicago 18, Ill.

Transistor Spec Chart 293

Comprehensive specifications for each type in a line of germanium junction-alloy transistors have been compiled in an easy-to-read chart. With the chart, in the same 4-page folder, there is an interchangeability guide which shows instantly what particular types may be interchanged for other standard transistors. Industro Transistor Corp., 649 Broadway, New York 12, N.Y.

TRUE DIFFUSED JUNCTION SILICON DIODES FOR HEAVY-DUTY POWER RECTIFICATION

THERMOSEN TYPE NO.	MAX. FWD. D.C. CURRENT*	PEAK INVERSE VOLTS	LEAKAGE MA.
P2505	25 AMPS	50	< 5
P2510	25 AMPS	100	< 5
P2520	25 AMPS	200	< 5
P2540	25 AMPS	400	< 5

*6" x 6" heat sink



ACTUAL SIZE

THERMOSEN offers for the first time the superior uniformity and reliability of true diffused junction silicon power diodes. These small, rugged, efficient devices are the best answer yet to your heavy-duty power rectification problems. Conservatively rated, hermetically sealed (guaranteed to 175°C), with an ambient temperature range of -65°C to +150°C, these diodes are reliable long-life components for new or replacement designs.

Thermosen has the experienced staff and complete facilities to develop and manufacture special electronic or semi-conductor diodes to your most exacting specifications.

THERMOSEN, INC. 375 FAIRFIELD AVE. • STAMFORD, CONN.

CIRCLE 294 ON READER-SERVICE CARD

Silicone Encapsulant 295

A 2-page data sheet, Reference 9-377, has been published to introduce Silastic RTV 501, a compound that vulcanizes at room temperature to form a silicone rubber suitable for encapsulating electric and electronic parts. The sheet lists properties and suggests applications. Dow Corning Corp., Midland, Mich.

Resin Properties 296

Epocast electrical insulating materials are characterized in a recent chart. Besides a tabulation of physical and electrical properties the chart contains notes on typical applications. The 11 x 22 sheet is folded and punched to fit standard notebooks. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

Magnetic Shield Cans 297

For convenience in specifying, Data Sheet 126 has a cutaway view of 3-layer rotary drawn magnetic shielding cans and a time saving checklist to indicate required

size, number of layers, construction and extent of magnetic shielding. It also has a page illustrating typical shapes, sizes, and constructions. Perfection Mica Co., Magnetic Shield Div., 1322 N. Elston Ave., Chicago 22, Ill.

Relays 298

Complete list of latest model relays is described in catalog now available. The 36-page catalog lists thousands of relays made by all leading manufacturers, including prices and model numbers for easy ordering. Relay Sales, Box 186, W. Chicago, Ill.

Scaler-Ratemeter 299

Bulletin N-8 gives a complete description of a portable, low cost scaler-ratemeter, that takes only 1/4 the area of conventional units and provides highly accurate measurements for nuclear labs, medical isotope studies, and atomic science training programs. Nucleonic Corp. of America, 196 Degraw St., Brooklyn 31, N.Y.

Brew Delay Lines

Brew will meet your requirements for . . .

- *performance*
- *price*
- *delivery*



distributed constant, lumped constant, ultrasonic

Advanced engineering and production techniques, most modern laboratory and test equipment, and large scale manufacturing facilities enable Brew to meet your most exacting delay line requirements. Here at Brew you have the *one source* for Distributed Constant, Lumped Constant, and Ultrasonic Delay Lines, and here you benefit from the expert knowledge, experience, and *complete cooperation* of one of the pioneer delay line manufacturers.

Available covering an extremely wide range of characteristics. Meet MIL Specs. *Send us specifications on your requirements.*



Richard D. BREW and Company, Incorporated

Concord, New Hampshire
design

•
development

•
telephone: CApitol 5-6606
•
manufacture

CIRCLE 300 ON READER-SERVICE CARD

ENGINEER OPPORTUNITIES AT RAYTHEON



ARMY'S HAWK MISSILE destroys attackers flying at even the lowest altitudes and in the blind zone of conventional radars. Raytheon engineers at the Bedford Laboratory work on this and other vital missile projects.

Advanced work with prime contractor for Army Hawk and Navy Sparrow III

The caliber of Raytheon engineering is an indication of the quality of our staff. Raytheon is the only electronics manufacturer with prime contracts involving complete systems responsibility for both air-to-air and surface-to-air missiles.

As an engineer in our Missile Systems Division, you associate with men of top national reputation in stimulating small groups. Our expanding development has created interesting openings in:

ELECTRONICS PACKAGING
CONTROL SYSTEMS
HYDRAULICS
SPECIFICATIONS

Send brief outline of experience and educational background to G. P. O'Neil, Raytheon Missile Systems Division, Bedford, Mass.

RAYTHEON MANUFACTURING COMPANY
Bedford, Massachusetts

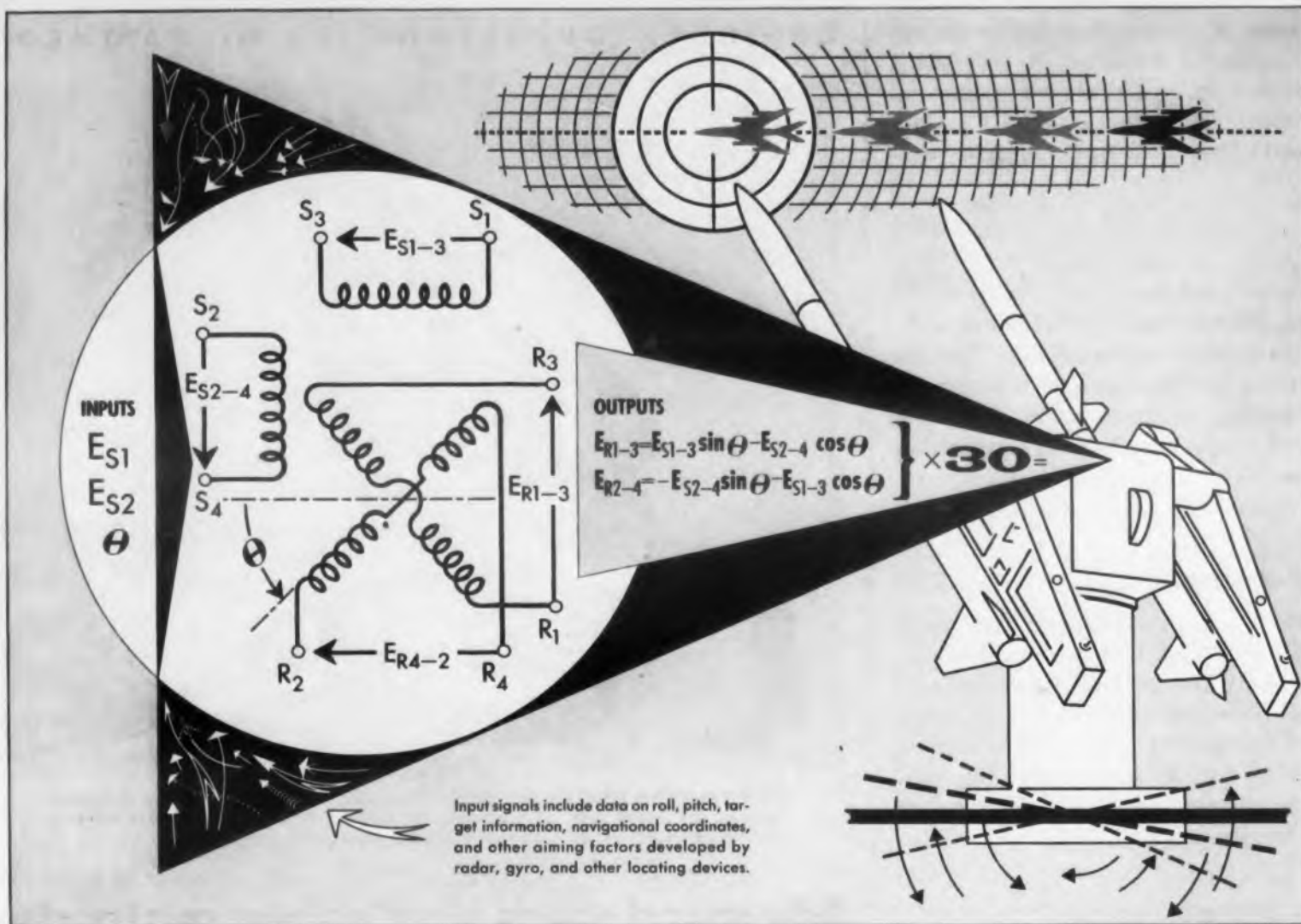
Are you the
ONE MAN IN THREE?



Excellence in Electronics

MISSILE SYSTEMS DIVISION





This New High Impedance Resolver by Norden-Ketay controls the Terrier missile from a rolling deck

Take the computer problem in aiming a supersonic missile from solid ground—add the variable factors of a rolling ship and a jet-propelled, airborne target. The answer to that problem combines 30 Norden-Ketay precision resolvers in a phenomenal computer capable of launching the Navy's 'Terrier' with incredible accuracy.

Norden-Ketay standard 105D2V Resolver met these difficult requirements perfectly for the Navy's 'Terrier' project—again demonstrating the value of the special characteristics designed into all Norden-Ketay components.

If your problem concerns computer accuracy or power, consider Norden-Ketay Resolver advantages. The high impedance circuitry requires smaller volume and reduces the size of power supply equipment.

Write for additional data on high impedance and other resolvers to:
Norden-Ketay Corporation, Precision Components Division, Commack, L.I., N.Y.

The high degree of accuracy and reliability of this new resolver helps the designer achieve new levels of performance in computer systems. Here is an outstanding example of the way Norden-Ketay developments simplify the solution of complex problems.

General Specifications

Norden-Ketay Type: 105D2V • Designated by BuOrd as Mark 4 Mod 1
Tuned Input: 12,000 ohms • Accuracy: $\pm 0.1\%$ • Frequency: 400 cps.



CIRCLE 302 ON READER-SERVICE CARD



New Literature

Audio Oscillator

303

An audio oscillator with an extended range of 9 cps to 100 kc is given complete technical coverage in a 1-page data sheet. To a description of the instrument's main features is added a list of specifications and an illustration. Waveforms, Inc., 333 Sixth Ave., New York 14, N.Y.

Flexible Shafts

304

Design features and specifications for a line of standard flexible shafts for solving a wide variety of power transmission and remote control problems are described in Bulletin 5608. The 4-page folder describes six shafts, three for remote control and three for power drive applications. Shaft components—inner shaft, neoprene casing and female couplings at each end—are discussed. Specifications, torque loads, drive speeds and similar data are given for all six models. Photographs illustrate each shaft. S. S. White Industrial Div., 10 E. 40th St., New York 16, N.Y.

Pressure Sensitive Tape

The use of pressure sensitive tapes under difficult conditions has been described and illustrated with actual tape samples in File 57TT1. Colorful, four pages, and of heavy cardboard, this 8-1/2 x 11 in. file lists the specifications and some of the applications of the sample tapes. To obtain a copy of this file, write on company letterhead directly to Tropical Tape Div., 899 Country Club Circle, Ft. Lauderdale, Fla.

Gold Plating

305

"Bright Gold Plating" an 8-page paper by E. C. Rinker, has been reprinted for free distribution. The paper treats in detail such topics as bath composition, equipment and operating conditions, and the comparative metallurgical characteristics of 24 carat gold plate on various base metals. Profusely illustrated with photomicrographs of gold plate surface and cross sections, the article also contains a series of graphs and tables indicating rates of deposition at various current densities and under different operating conditions. Sel-Rex Corp., P.O. Box 187, Nutley 10, N.J.

Crystal Filters

306

The major characteristics of a standard line of crystal filters have been summarized in a 4-page catalog. The text is supported with specification tables, outline drawings, a typical characteristic curve, and a circuit diagram. Hycon Eastern, Inc., 15 Cambridge Parkway, Cambridge 42, Mass.

Analog-to-Digital Conversion

307

An article entitled "Analog-to-Digital Conversion" has been reprinted for distribution. The text discusses the various types of analog-to-digital converters with particular emphasis on the voltage sweep converter. It cites examples of the instrument's operation and explains how the final digital value of the original analog inputs is reached. The material was reprinted from the *Proceedings of the 1956 Symposium on Automatic Data Logging Systems*. Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif.

Nylon Bobbins and Washers

308

Complete specifications on nylon bobbins and washers are contained in a 4-page illustrated catalog. The catalog announces the availability of bobbins and washers manufactured to specifications and also a complete line of stock sizes and shapes. Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio.

High Speed Rotary Switches

309

High speed rotary switches for telemetering, programming, sampling, and scanning are introduced in a 2-page leaflet. The switches are available for 45 contacts at 20 rps, 90 contacts at 10 rps and 30 contacts at 30 rps. The illustrated sheet shows a typical contact arrangement and circuit applications. Instrument Development Labs., Inc., 67 Mechanic St., Attleboro, Mass.

New Type Magnetic Tape Unit

310

A 6-page brochure has been issued to introduce a new type of magnetic tape handling unit with built-in controls. Designed especially for the Univac File-Computer System, this automatic tape unit can make its own comparisons and its own logical decisions because of its self-controlling features. Complete tape sorts and tape collations can be made independently of the central computer program. Remington Rand Univac Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N.Y.

DO YOU KNOW

... transistors can be 20-30 db less noisy than low noise vacuum tubes?

These two companies use the new "hushed transistor" circuit in their most sensitive instruments.



SENSITIVE
AC & DC
VOLTMETERS
LOW NOISE
LOW DRIFT
10 UV
FULL SCALE

Type MV - 45A
TRANSISTOR
VOLTMETER
Range:
2 uV to 1 kV
2 cps to 150 KC

"Hushed Transistors" (having zero or reversed collector junction voltage) exhibit noise voltages, referred to their shorted input terminals, which are at least 20 db lower than the noise voltages of the finest low-noise vacuum tubes, available today. In a direct coupled circuit they also have less drift. Our new transistor voltmeters for AC and DC have lowest ranges of 10 uV and highest ranges of 1 kV full scale.



MILLIVAC INSTRUMENT CORP.

BOX 997, SCHENECTADY, N. Y.



SENSITIVE
AC & DC
AMPLIFIERS
SINGLE &
PUSH - PULL

Type VS - 64A
LOW NOISE
AC-AMPLIFIER
Gain: 80 db
 $E_{Nsh} = 0.45 \mu V$
($B = 60 \text{ kc}$)
Range: 2 cps-180
kc.

The discovery of the principle of "Hushed Transistor" operation by Dr. W. K. Volkert and Mr. Norman E. Pedersen, which was first disclosed at the National Electronic Conference in Chicago, a year ago, has led to the development of pre-amplifiers for AC and DC which have less than 500 muV RMS noise voltage, referred to the shorted input terminals. These amplifiers have been in production during the past 12 months and have given an excellent account of themselves.



VOLKERS & SCHAFFER MFG. CORP.

Box 996, Schenectady, N. Y.

CIRCLE 311 ON READER-SERVICE CARD



OK Boss, you tell 'em how we're gonna revolutionize the party line telephone system with transistor oscillators controlled by . . .

NEW REEVES-HOFFMAN LOW FREQUENCY CRYSTALS

New Reeves-Hoffman low frequency crystals, type RH8-DP, offer excellent frequency stability over a temperature range of -55° to $+105^{\circ}\text{C}$. Available from 4 to 15 kc, they are designed for use not only in telephone carrier and communications systems, but in aircraft navigation, guided missile, sonar, telemetering and test equipment as well. These crystals meet MIL C-3098B specifications for shock, vibration, aging and moisture resistance.

WRITE FOR BULLETIN RH8-DP



DIVISION OF
DYNAMICS
CORPORATION
OF AMERICA
CARLISLE,
PENNSYLVANIA

REEVES-HOFFMAN SPECIALIZES IN VOLUME PRODUCTION OF CRYSTALS FROM 1 MC DOWN

CIRCLE 312 ON READER-SERVICE CARD



MODEL 212A . . . 0 to 100 V dc,
100 ma. Regulation 0.1% or 0.02
volt over entire range of load and
input voltage. Weight 14 lbs.
3 1/2" H x 19" W x 9 1/4" D. Price
\$129.00 unmetered.



FOR THE BEST IN
STRAIN GAUGE
PERFORMANCE

POWER WITH[®] REGATRON

REGATRON Power Packs are ideally suited for excitation of resistance-type strain gauges.

The REGATRON circuit is such that even with the output control set at a fraction of a volt there is no loss of specified regulation, output current capabilities or stability.

Available in voltage ranges up to 100 and currents up to 3 amperes. All models have a continuously variable main voltage control and a vernier control for fine adjustments . . . and only REGATRON Power Packs are remotely programmable for process control and automation. Write for bulletin.

® Registered U.S. Patent Office.
Patents Pending.



MEASUREMENTS COMPANY
INCORPORATED

EATONTOWN • NEW JERSEY

CIRCLE 313 ON READER-SERVICE CARD

New Literature

Electrical Steel

Electrical Steel 4750 is exhaustively covered in a recent revision of Blue Data Sheet EM-16. Punched for notebook insertion, the 20-page booklet describes in detail the iron-nickel steel and its physical, mechanical and magnetic properties. Sixteen graphs supplement the text. Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.

Investment Casting

To acquaint the design engineer with the many opportunities of producing precision parts and components by the investment casting method is an important purpose of a 14-page brochure now available. An ample supply of pictures shows plant facilities and the process in action, while a detailed text explains the advantages and steps involved in the manufacture of castings. The Hitchiner Mfg. Co., Milford, N.H.

314 Silicone Resin

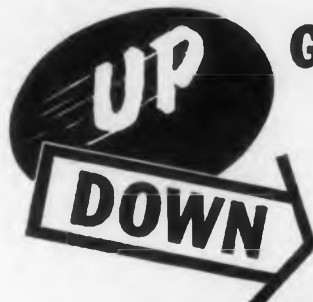
"Silicone Notes" is a data sheet concerning a new silicone resin, R-7141, for bonding low pressure structural laminates. It describes applications, processing, and properties of this resin which was specifically developed for the vacuum-molding of complex structural parts. The R-7141 provides high strength at elevated temperatures, excellent thermal stability, and low dielectric losses. Dow Corning Corp., Midland, Mich.

Linear Amplifier

Model 672A Linear Amplifier for use with radiation detectors, and built to ORNL specifications Q1326 is described in bulletin now available. The illustrated 2-page bulletin Form 3001-7 gives complete electrical and mechanical specifications, performance data, and lists potential uses and applications for the equipment. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

316

317



GOES DIELECTRIC STRENGTH

(Up to 2,500 VRMS* as required by MIL Specs—even up to 3,000 VRMS*)

GOES INTERNAL TEMP. RISE

(25% cooler internal hot spot)

50 WATT
0.3 to 60,000 ohms



25 WATT
0.1 to 16,000 ohms



Tolerances
from 3%
to .05%

Meet all requirements of applicable military specifications in existence or in prospect.

*GUARANTEED (AT SLIGHT PREMIUMS)

NEW SAGE Type "M" (Metal-clad) "Silicohm" Resistors Give You BOTH!

If you have been stumped because miniature, chassis-mounted resistors in the past offered only 1,000 VRMS dielectric, then here's good news. Thanks to a superior, new type of filling material and new production techniques, SAGE now offers this new, improved, precision wire-wound resistor with a *standard* rating of 1,500 VRMS dielectric strength—and up to 3,000 VRMS on special order. And the cooler hot-spot means longer life, improved stability and greater all-around reliability.

Complete data available on request

SAGE

ELECTRONICS CORPORATION

302 North Goodman St., Rochester 7, N.Y.

CIRCLE 318 ON READER-SERVICE CARD

High-Voltage Power Supply 319

An illustrated specification bulletin, Form 3000-7, on the Model 683 high-voltage power supply has been announced. The bulletin covers principles of operation, gives suggested uses for the ultra-stable well regulated supply, and lists detailed electrical and mechanical specifications. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Printed Circuit Connector 320

Claimed to be the longest precision printed circuit connector known, the Continental Connector is discussed in a 2-page, illustrated bulletin recently released. Presenting specifications, diagrams, and general information for this device, the technical bulletin also explains computer application. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N.Y.

Rivets 321

An illustrated 2-color catalog describing the line of PT (pull thru) and 9SP (self-plugging) blind rivets has been released. It

lists the advantages of the two types of blind rivets and illustrates a number of typical applications with easy to understand cross-section drawings. Huck Manufacturing Co., 2480 Bellevue Ave., Detroit 7, Mich.

Jevis 322

Jet Engine Vibration Indicator System (Jevis) for pure jet, turbo-jet, or turbo-prop engine vibration level indication is described in Bulletin 57—now available. Specifications are given for the three package system—pickup, amplifier, and meter switching. Land-Air, Inc., a subsidiary of California Eastern Aviation, Inc., 7444 W. Wilson Ave., Chicago 31, Ill.

Nylon Wire Clamps 323

A 4-page folder has been devoted to nylon wire clamps for securing wires in aircraft, missile, and electronic assemblies. Tables showing available hex and flathead screw mounted types follow a brief descriptive section. The folder also contains short procurement notes and a table of properties. Dakota Engineering, Inc., 6641 Crenshaw Blvd., Los Angeles 43, Calif.



photo courtesy of Emerson Research Laboratories

WELDMATIC PRECISION WELDING IMPROVES COMPONENT RELIABILITY FOR EMERSON

Joining lead wires to magnetic amplifiers was a problem at Emerson Research Laboratories. However, using a Weldmatic Model 1012 welder, they found they could join materials like #40 nickel iron resistance wire and #24 tinned copper both quickly and easily. Resulting joints proved *reliable*—able to withstand severe vibration, acceleration and high temperature. With Weldmatic welders you can simplify miniaturization, speed production. Write for technical data on the Weldmatic line.

WELDMATIC DIVISION OF UNITEK CORPORATION
260 North Halstead Avenue • Pasadena, California
SALES ENGINEERING REPRESENTATIVES IN PRINCIPAL CITIES
CIRCLE 324 ON READER-SERVICE CARD

Ace can meet your requirements in quality and delivery of **NONLINEAR POTENTIOMETERS**

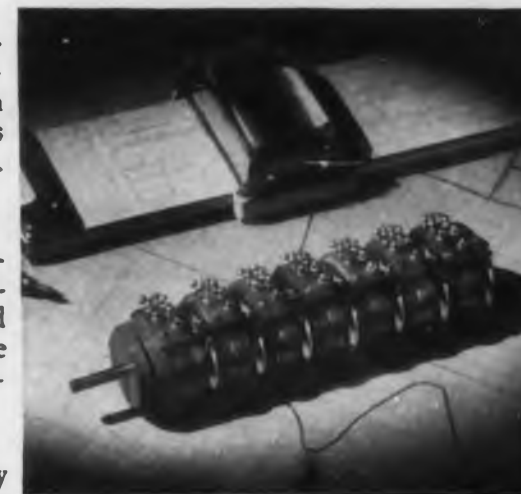
Nonlinear precision wire-wound potentiometers in standard and sub-miniature sizes are now available in prototype or production quantities from Ace Electronics Associates . . . and you can be sure of delivery.

These new Ace nonlinear units incorporate the same advanced engineering, precision craftsmanship, and controlled quality which have made ACEPOT linear potentiometers standards of excellence.

A new Division directed by highly qualified engineers, special prototype section, and mass production facilities are at your service to meet your requirements for quality and delivery of nonlinear precision potentiometers.

For complete information . . .

Call or write William Lyon or Abraham Osborn, Nonlinear Division, outlining your requirements. Your inquiry will receive prompt attention . . . and you will get delivery as specified.



Featuring!

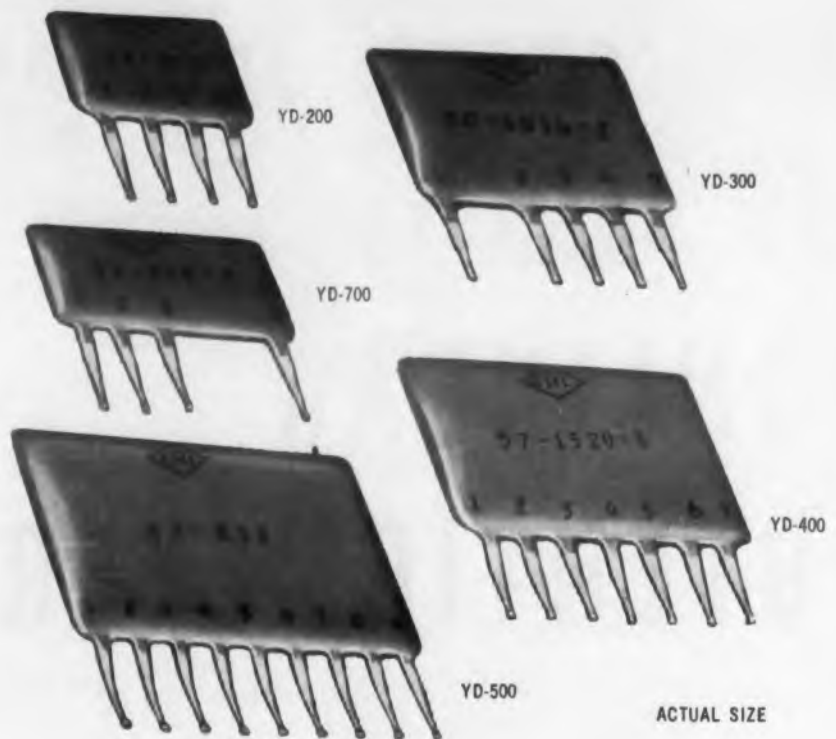
Highly developed design techniques achieve high resolution and close conformity for your unique nonlinear requirements.

* trademarks applied for
ACEPOT*
ACETRIM* **ACE ELECTRONICS ASSOCIATES, INC.**

Dept. ED, 101 Dover St. • Somerville 44, Massachusetts
Telephone: 50merset 6-5130 • Engineering Representatives in Principal Cities

CIRCLE 325 ON READER-SERVICE CARD

More circuit flexibility ...more compact design



from these five standard Couplates[®]... Centralab PEC's^{*} (Packaged Electronic Circuits)

Centralab can adapt the five basic shapes shown into an infinite number of electronic circuit combinations to meet your requirements. In addition, you have a choice of leads — narrow tab (shown), wide tab, long wire, stub wire, and crimped wire.

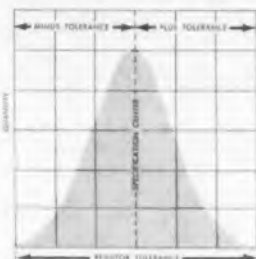
These packaged electronic circuits incorporate resistors, capacitors, wiring, and often inductance in one compact sub-assembly. They're thinner . . .

have less height and depth than competitive makes. You save space, simplify assembly, reduce inventory, and eliminate testing of individual components. What's more, Centralab PEC's guarantee circuit performance under extreme operating conditions.

See your local CRL distributor who has more than 90 standard circuits on hand, or write direct for complete information.

*TRADEMARK

All resistors are produced to nominal resistor values



Circuitry performance is more stable because the tolerance is a distribution over the nominal and not fringe values.

Y-4158

NOW! Extended Capacity Ranges



Maximum capacities: 150 to 600 volts up to .5 mf 6 volts up to 2.0 mf.

This increases the scope of P.E.C.'s for your applications.

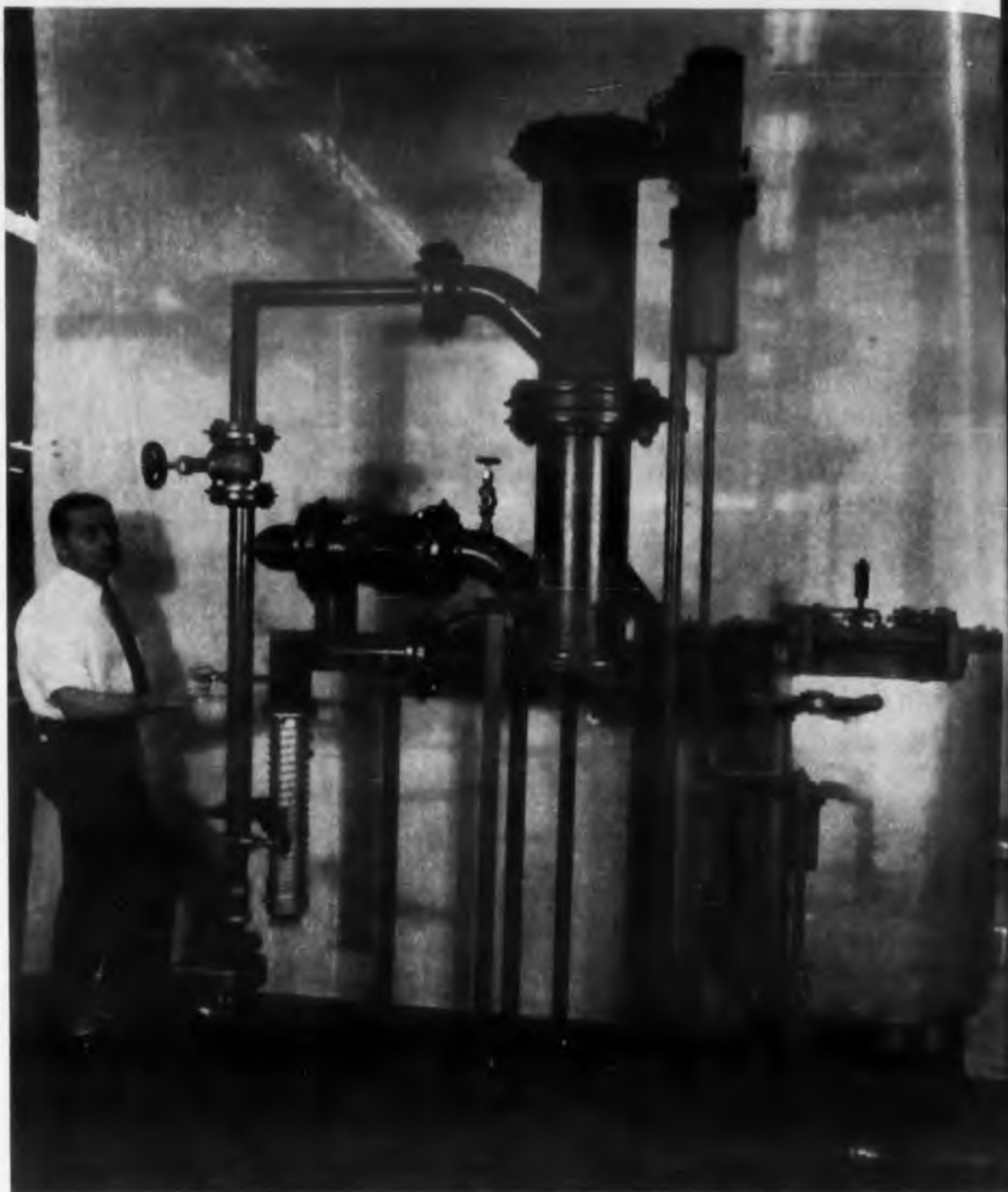
Centralab

A DIVISION OF GLOBE-UNION INC.
960K EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: 804 Mt. Pleasant Road • Toronto, Ontario

CIRCLE 326 ON READER-SERVICE CARD



High Vacuum Impregnation



This high vacuum impregnation plant developed by NRC Equipment Corporation is used for experimental or small scale production of capacitors or transformers. The system employs a booster diffusion pump with the rotary gas ballast mechanical pump at the lower left to produce pressures down to 0.1 micron of mercury. The two-stage degassing column in the center is used to remove air and volatile fractions from the impregnating fluid before it is fed to the impregnating chamber at right.

Comparison of High Vacuum vs Conventional Vacuum Impregnation of Capacitors

Process	Pressure mm of Mercury	Capital Investment	Production Rate	DC Insulation Resistance
High Vacuum	0.001 to 0.0001 mm.	\$10,000	1000/hr	10^{12} ohms
Conventional Vacuum	0.1 mm.	\$ 8,500	1000/hr	10^{10} ohms

Exp

A NE
se
as bee
contami
quipm
to the
corpor

Esse
incorpo
ating
nsive
sulte
oltage
The
he h
tractio
nd tra
ower
Alth
ormen
ncaps
well a
Where
rinte
XXP
rove
amine
The
invest
apac
nd c

Equ
br hi
dly
nce
high
me,
produ
impro
would
would
quire
ment
Off-
may

ELEC

reduces

Expensive Rejects

A NEW process developed by National Research Corporation in Cambridge, Mass. has been announced for removing moisture and contaminants from electronic and electrical equipment prior to encapsulating. Equipment to do the job is available from NRC Equipment Corporation, Newton Highlands, Mass.

What It Does

Essentially a high-vacuum pumping system incorporating provision for introducing encapsulating material into evacuated equipment, extensive tests by a capacitor manufacturer have resulted in greater reliability, higher breakdown voltage and higher dc resistance.

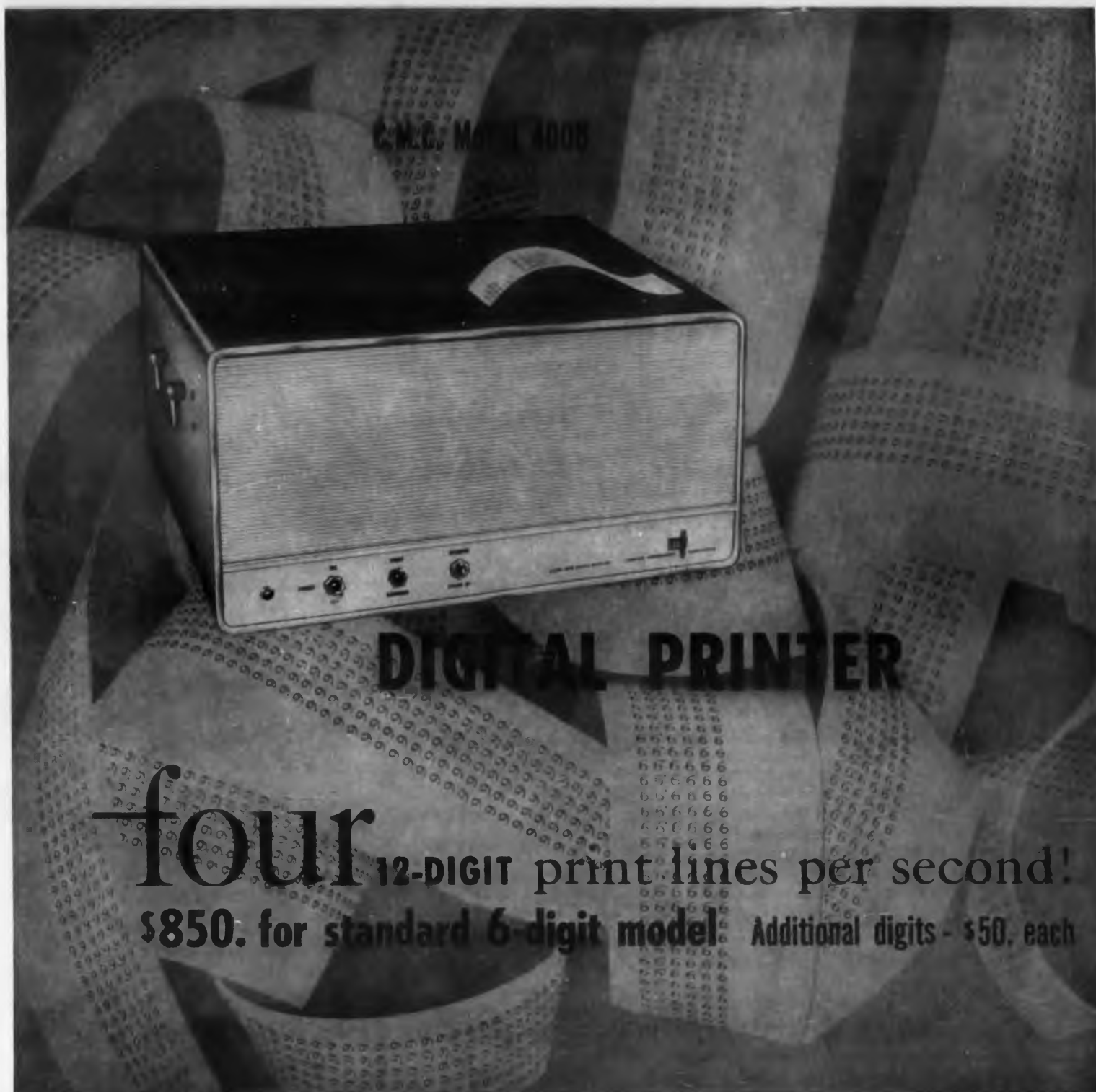
The vacuum achieved is below 100 microns. The high vacuum not only removes gases but practically eliminates every trace of water vapor and trapped air that normally gives trouble with lower vacuum evacuating systems.

Although applied so far to capacitor and transformer manufacture, the process is applicable to encapsulation of modules and coaxial cables, as well as coating of printed-circuit boards, etc. Where moisture absorption is a problem in printed-circuit work, vacuum impregnation of CXP punching-grade low-cost laminate could prove less expensive than resorting to more costly laminate material that is not so easily fabricated.

The accompanying chart compares vacuum, investment cost, production rate and resulting capacitor insulation resistance by high-vacuum and conventional vacuum impregnation.

Cost

Equipment cost is about 20 per cent greater for high-vacuum equipment which will undoubtedly increase individual component cost. But since there will be less component rejects, the higher reliability should allow less inspection time, resulting in labor savings. A small (pilot production) high-vacuum system, would allow impregnation of about 200 capacitors a day, would cost about \$2500. A small production unit would cost about \$10,000. Since customer requirements in this field vary widely, each equipment is engineered to fit the user's needs. "Off-the-shelf" high-vacuum impregnating units may soon be available.



Operates with most existing counting equipment

WITHOUT MODIFICATION! A reliable, accurate, compact instrument that fills an industry need for a truly high-speed, low cost digital printer. It may be connected directly to digital counting instruments and will print, on standard adding machine tape, the count measured during each counting sequence. Important features include: Parallel Entry, No Stepping Switches, Relays or Moving Contacts.

Furnished standard with 6 digit print-out

but up to 12 digits is optional. Write today for complete specifications

Dept. 76-N

Computer-Measurements

5528 Vineland Ave., No. Hollywood, Calif.



Subsidiary of
Hancock
Manufacturing
Company

CC-82

CIRCLE 327 ON READER-SERVICE CARD

New!



Miniature *Precision* Rotary Selector Switch

Here's the exceptionally positive action only a multi-leaf wiper, button-contact switch can offer—now in the smallest sizes consistent with the quality and dependability required for today's compact, precision equipment:

- Features solid silver alloy button-type contacts, collector rings, and spring suspension leaf-type wiper arms for low contact resistance—0.002 ohms.
- Integral lugs and contacts staked in glass-fibre Silicone-laminate stators. Lugs cannot turn or loosen. Stator material will not carbonize even if severely overheated. Terminations can be made mechanically secure *before* soldering.
- Molded Melamine rotor covering entire contact circle provides high voltage breakdown between decks.
- Outstanding moisture, humidity, and salt-spray resistance through use of passivated stainless steel, nickel-plated brass, Steatite, Nylon, molded Melamine, and Silicone-base glass-fibre laminate parts.
- Adjustable stainless steel stops—easily positioned.
- Uniformly high quality—cost-reducing mechanized production and assembly.
- Small size—only $1\frac{3}{4}$ " square. 1" deep for first deck, only $\frac{5}{8}$ " deep for additional decks.

CONDENSED SPECIFICATIONS

Shallcross "Miniature Series"

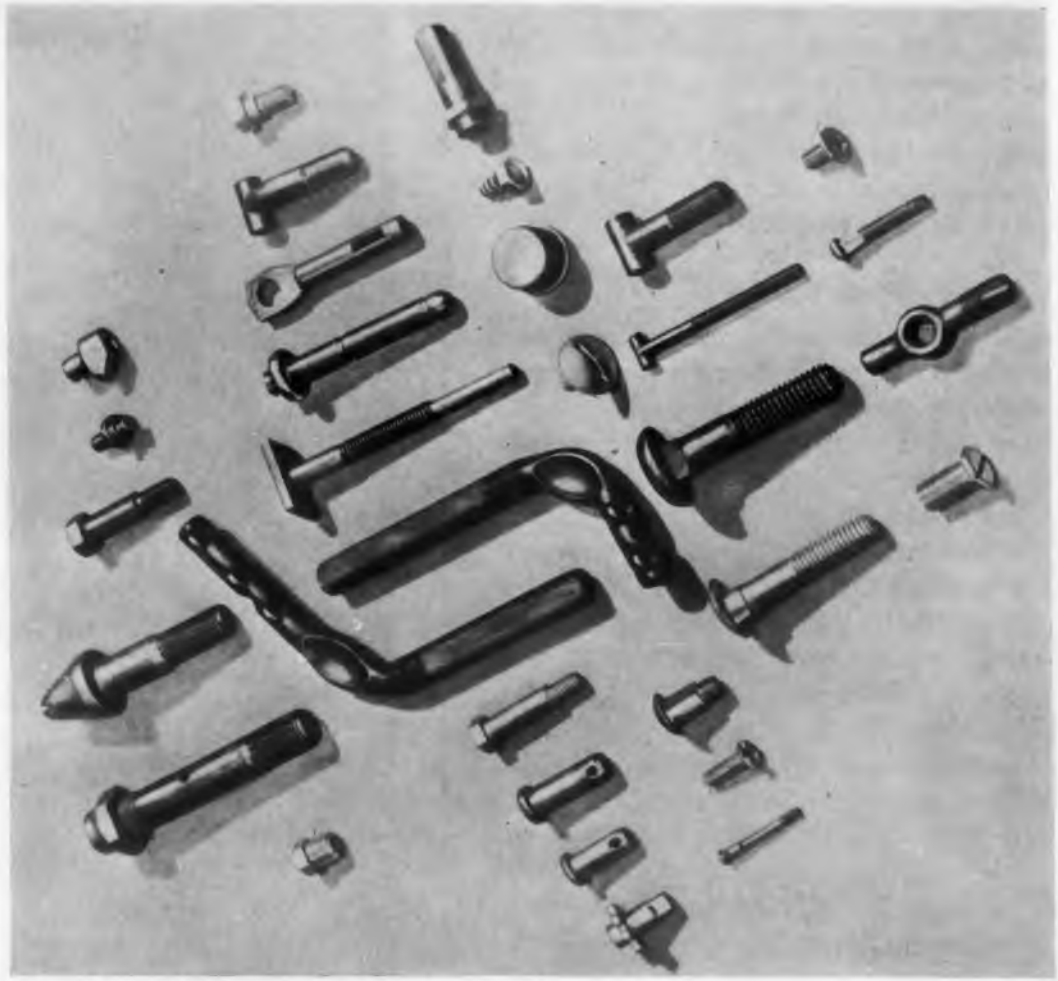
POLES PER DECK—1 to 4.
INDEXING (detent)— $11\frac{1}{4}^\circ$, 15° , $22\frac{1}{2}^\circ$, 30° .
MOUNTING—Single or 2-hole, with non-turn tang.
OPERATING VOLTAGE—to 1500 volts.
BREAKDOWN VOLTAGE—to 4000 volts.
BREAKING CURRENT—5 amp @ 125 V. ac.
CARRYING CURRENT—15 amp.

Shallcross

SHALLCROSS MANUFACTURING COMPANY, 526 Pusey Avenue, Collingdale, Pa.
CIRCLE 328 ON READER-SERVICE CARD



Save Money on Cold Headed Parts



Typical range of components economically produced by cold heading. This is the same process by which bolts and cap screws are produced with mass economy. (Russell, Burdsall & Ward Bolt and Nut Co.)

COLD HEADING—a process that permits the fastener industry to produce a billion bolts and cap screws annually at low cost—is now replacing machining in the production of a multitude of threaded and unthreaded small metal parts. This is because cold heading produces a stronger piece at lower cost.

Cold heading flows and compresses steel fibers, making the bolt or other part stronger than the blank from which it is made. Because little or none of the material is cut away, there is little or no scrap loss. Unsound metal will open or distort when cold headed, so the process has built-in quality control. And because of the rapidity of cold heading machines, direct labor costs are reduced at least 25 per cent under those made by automatic machines that cut out parts.

Determining whether a piece may be more economically machined or cold headed requires

no con
Russell
a pion
falls w
be col
depend
sign of
skill of
The
to help
and ke
■ Max
today'
mum o
locatio
volum
the sh
transf
three
have l
■ Min
headin
of co
metho
paid o
one d
large
■ A v
cold l
exper
for co
0.45.
nicke
metal
copp
tain s
which
cold
select
any r
■ Co
than
many
secti
ing r
■ Sh
radii
■ Ov
than
upse
■ Ho
tend
■ Le
■ La
to re
ridg
■ Lo
sequ
Ru
Part
ELEC

no complex formulas, according to engineers of Russell, Burdsall & Ward Bolt and Nut Company, a pioneer in cold heading. Almost any part that falls within the capacity of today's machines can be cold headed successfully. Good cold heading depends upon selection of proper material, design of punches, conditions of machines and the skill of the operator.

There are, however, useful rules of thumb to help determine the feasibility of cold heading and keep costs down. Here are some factors:

- Maximum length of a cold headed part in today's machines is generally about 6 in. Maximum diam depends upon shape of the piece and location of the upset. For straight upsetting, a volume of material equal to 4-1/2 diameters of the shank is about the limit. However, with transfer headers—using double extrusions and three blow headers or reheaders—26 diameters have been successfully controlled and upset.

- Minimum number for an economical cold heading production run depends on design and, of course, the cost of alternative processing methods. Generally the cost of setting up can be paid off by the faster speed of cold heading in one day's run—about 25,000 pieces for a fairly large part.

- A wide variety of metals can be worked by cold heading. Cold heading steel becomes more expensive as carbon content increases—especially, for complex shapes. It's best to limit carbon to 0.45. Many alloys are practical, including chrome nickel and chrome molybdenum. Non-ferrous metals, such as silicon bronze, Monel, brass and copper are all good cold upsetting materials. Certain stainless steels can be used, too. Materials which work harden rapidly are not practical for cold heading. Metallurgists in the industry can select a material for cold heading with almost any mechanical characteristics.

- Concentric formations are easier to handle than off-center or eccentric sections. However, many parts having eccentric cams, serrations or sections are produced successfully in cold heading machines.

- Sharp corners are difficult to fill. Generous radii should be allowed if possible.

- Oval or round shapes require less trimming than square or rectangular shapes because the upset is usually made cylindrical in the header.

- Hollow upsets cause die maintenance, cracks tend to form around the edges of the recess.

- Lettering or embossing is expensive.

- Large sections with a flat underside are easier to remove from a die when there are concentric ridges on the underside.

- Long sections are more likely to distort if subsequent heat treatment is required.

Russell, Burdsall & Ward Bolt and Nut Co.,
Port Chester, New York.

Honeywell develops new transistor for high-fidelity equipment

First Power Tetrode!



Faithfully reproduces input signals—frequency response improved 50%!

NOW, FOR the first time, you can get a transistor that gives low audio distortion, high efficiency and high power output—with high impedance drive and without feed-back.

This performance is now provided by the new Honeywell H200E Tetrode Power Transistor. The Power Tetrode has *two* separate base connections permitting control of the device characteristics.

In addition to improved linearity, *Frequency Response* is increased 50% over triode transistors!

Also, *Thermal Stabilization* of the Power Tetrode is achieved more easily than with triode transistors because of the second base connection. This stabilization can be achieved even with high impedance drive, allowing high temperature operation of direct coupled circuits using Power Transistors.

The H200E is a germanium PNP alloyed junction power transistor designed to operate on 28-volt systems with currents up to 10 amperes. Its thermal resistance is less than 1°C/watt.

The Power Tetrode is available in sample quantities. Get complete information by writing Honeywell, Dept. ED-11-262, Minneapolis 8, Minn. Regional representatives may be reached in Union, N. J. (MURdock 8-9000), Boston (ALgonquin 4-8730), Chicago (IRving 8-9266), and Los Angeles (RAYmond 3-6611 or PArkview 8-7311).

Honeywell



First in Controls

CIRCLE 329 ON READER-SERVICE CARD

new!...

RUGGEDIZED Continental Connectors

NOW RUGGEDIZED TO WITHSTAND SHOCK AND VIBRATION EXTREMES



7 Contacts MM7-22



14 Contacts MM14-22



20 Contacts MM20-22



34 Contacts MM34-22

ACTUAL SIZE

- ★ Smallest size without sacrifice of performance
- ★ Available in 5, 7, 9, 11, 14, 20, 26, 29, 34, and 44 contacts
- ★ Positive polarization reversed guide pin and guide socket
- ★ Melamine . . . Plaskon . . . Diallyl Phthalate Molding Compounds
- ★ Available with hoods, screwlocks and protective shells

ELECTRICAL AND MECHANICAL RATINGS

Voltage Breakdown:	
At Sea Level	1800 Volts RMS
At 60,000 Ft.	450 Volts RMS
Current Rating	3 Amps.
Solder Cup (MM-22)	#22 AWG Wire
Minimum Creepage Path Between Contacts	1/8"
Minimum Air Space Between Contacts	3/64"
Contacts, Center-to-Center	3/32"
Pin Diameter (MM-22)	.030"

Technical data sheets on micro-miniature and other Continental Connectors are available on request. Specify your requirements to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, N. Y.

You're
always
sure
with

DeJUR

electronic
components

electronic sales division
DeJUR-AMSCO CORPORATION
45-01 northern boulevard
long island city 1, n. y.

CIRCLE 330 ON READER-SERVICE CARD



Ideas for Design

Felt Seals

Somewhat newer in the field of joint design results from the use of various type sealants. The following material points up possibilities for use of sealants in electronic design. No attempt is made here to exhaust this subject; sealing articles will be published from time to time giving specific design information.

Sealants, such as plain and impregnated felts, can be used for sealing and cushioning applications. Many sealing problems can be met by the following materials, each of which can be secured with pressure sensitive tape, or with "dry back" solvent actuated adhesive:

1. impregnated wool felt sealing tapes and cut gaskets;
2. sponge rubber tapes and cut gaskets (natural and synthetic, open and closed cell);
3. foamed vinyl tapes and gaskets (closed cell);
4. cork and rubber tapes and gaskets; and
5. foamed polyurethane tapes and gaskets.

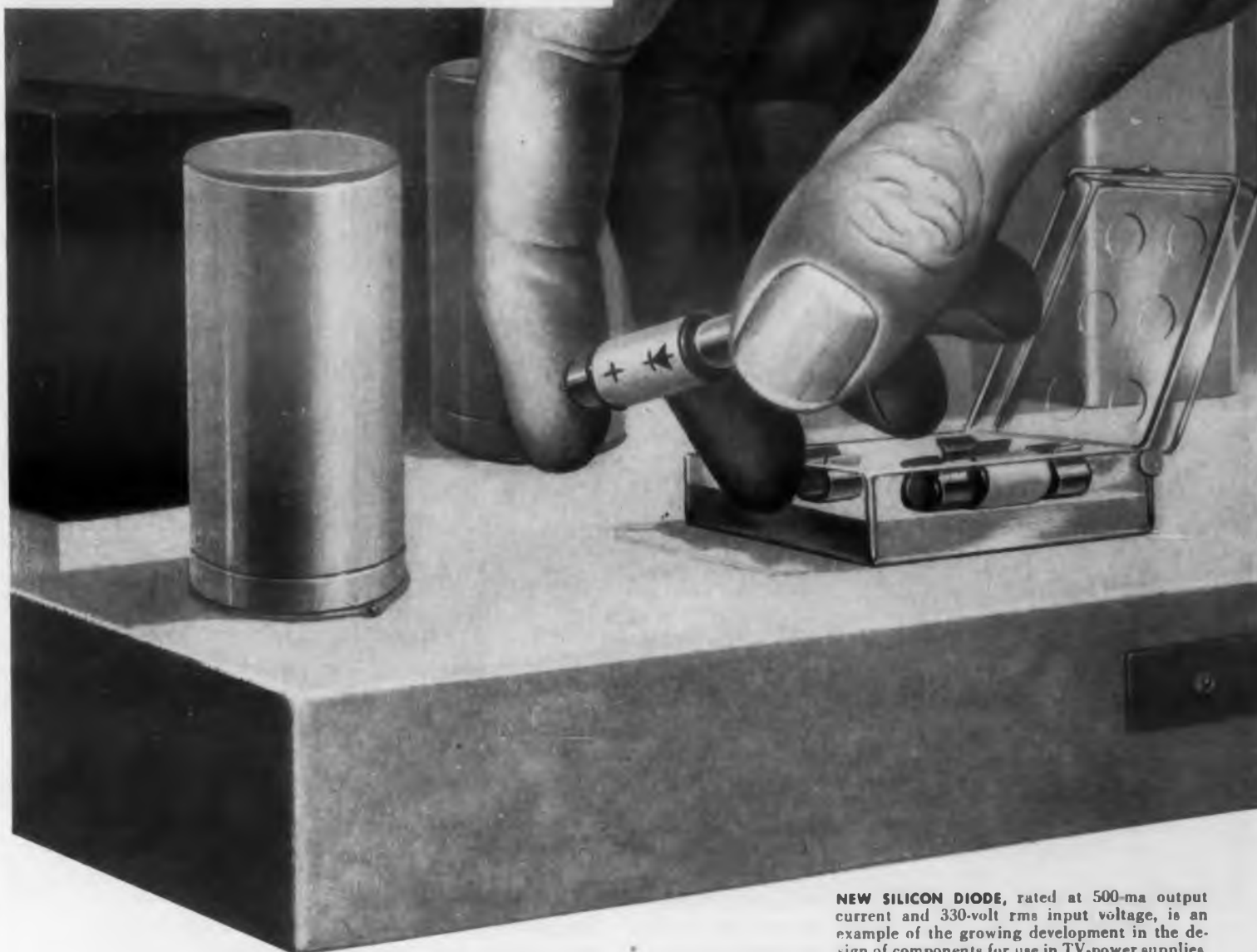
The improved felt sealing tapes seal against dust, dirt, wind, fumes, moisture, infestation, vibration, electrolysis, and corrosion. They are available in a wide variety and range of forms for industrial use. By selecting the proper form it is often possible to speed up assembly-line operations and reduce production costs.

Composition

The impregnated-felt tapes consist of commercial grades of wool felt which have been impregnated by a "hot melt" process. The impregnant is a permanently plasticized mastic sealant. By using a "hot melt" process—rather than a low temperature solvent-escape impregnating system formerly used—the sealant is rendered stable by preventing the progressive escape of the solvent. After impregnation, the tape is cooled and the pressure sensitive adhesive is sprayed on one side. The finished product is then wound onto large master rolls 36 to 40 in. wide, and later, slit, cut, and segmented, for various applications.

Selection of wool felt as the base material was prompted by low cost plus indestructability and the fact that felt tends to act to force the sealant to remain within its body or structure, instead of being forced out at the point where pressure is exerted. *Lyne S. Metcalfe, 51 E. 42nd St., New York, N.Y.*

NEWS ABOUT SILICON DEVICES



NEW SILICON DIODE, rated at 500-ma output current and 330-volt rms input voltage, is an example of the growing development in the design of components for use in TV-power supplies.

Now... more efficient power supplies for radio-TV made possible with Du Pont Hyperpure Silicon

Actual test results as reported by various manufacturers indicate important advantages of silicon diodes and rectifiers. One TV manufacturer, for example, operated samples of silicon rectifiers under load continuously for 5,000 hours—with no noticeable drop in output voltage. Another manufacturer reports no voltage change after 500 hours in 95% humidity.

Silicon-equipped sets are relatively free of a decline in B+ voltage. Silicon diodes are up to 99% efficient in units operated at 60 cps—reverse leakage is as low as a few microamperes. Both rectifiers and transistors of silicon have temperature ratings far higher than those of other semiconducting materials... can operate continuously at -65° to 200°C .

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use... having a purity range of 3 to 11 atoms of boron per billion. Technical information is available on crystal growing from Du Pont... pioneer producer of semiconductor-grade silicon.



NEW BOOKLET ON DUPONT HYPERPURE SILICON

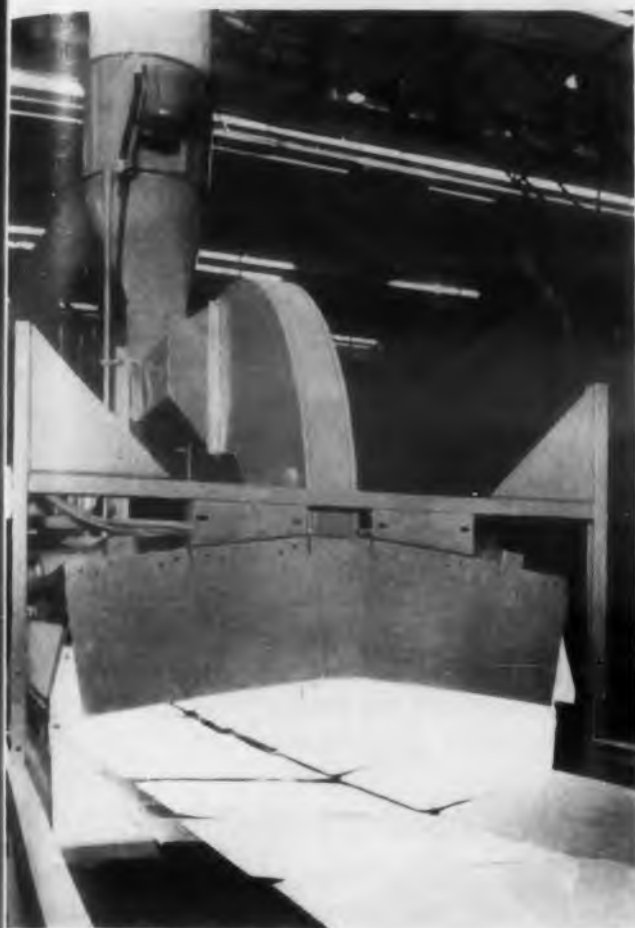
You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. For your copy write to: E. I. du Pont de Nemours & Co. (Inc.), Silicon N-2496-ED-11, Wilmington 98, Dela. (This offer is limited to U.S. and Canada.)

CIRCLE 331 ON READER-SERVICE CARD

PIGMENTS DEPARTMENT



BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY



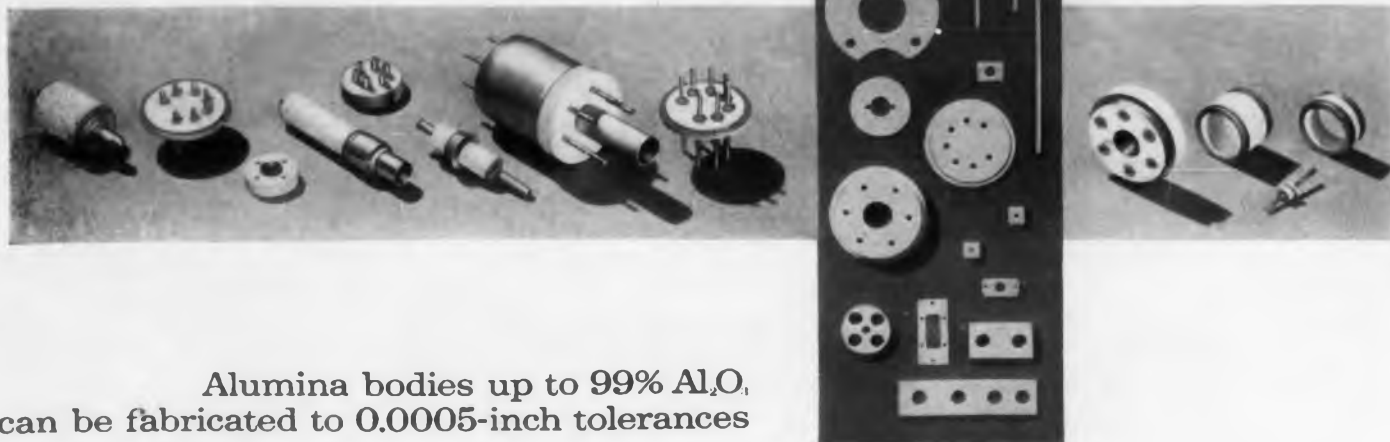
This 22-foot Fostoria Radiant Oven dries adhesives on steel sheet and a laminate in 1-1/2 minutes, before placing both sheets back to back and permanently bonding them with pressure applied by pinch rolls.

Plastic-to-Metal Laminate

In metal joining, laminate bonding with adhesives is finding many applications formerly performed by welding, riveting and fastening. It is being used to join dissimilar metals, and metals to non-metals, including glass, plastics, wood and ceramics. Radiant ovens dry the adhesives, prior to bonding various materials into a "sandwich" and passing them through a pinch roll. In many industries, the use of radiant ovens has enabled manufacturers to bond laminates on an assembly-line basis. In addition to providing better bonding results, advantages gained by the infrared drying process include a reduction in drying time to a matter of seconds which helps to conserve valuable floor space, speed up processing and shipping operations. Radiant oven drying often provides stronger bonding of materials by preventing moisture condensation on the laminate. A special ventilating system removes solvents from the adhesive during the heating process.

The Fostoria Pressed Steel Corporation, Fostoria, Ohio.

Now... Ceramics from Sylvania...



Alumina bodies up to 99% Al_2O_3 can be fabricated to 0.0005-inch tolerances

The excellent physical, thermal and dielectric properties of high-alumina ceramics are now available in precision components from Sylvania. Sylvania's Ceramics facility, established in 1947, offers outside industry an integrated custom service for high-precision ceramic parts and ceramic-to-metal vacuum-tight composites. Complete technical assistance and prototype development programs make it easy for designers to experiment with new and challenging

applications made possible by high-alumina ceramics.

Dimensional tolerances previously considered impractical to attain in as-fired high-alumina ware have been achieved by Sylvania through improved fabrication techniques and rigid production controls. Complete engineering control is maintained from raw material selection through final firing. Properties of finished ware can be reproduced time after time with complete uniformity.



• **Prototype Development:** Prototypes, in a full range of sizes and shapes, can be produced in small quantities at reasonable cost. Progressive prototypes, as illustrated, are made practical by hand tooling, which minimizes development costs and saves valuable engineering time. Sample parts can often be completed within 15 days.



• **Ceramic-to-metal Composites Fabrication:** High-temperature, vacuum-tight seals, both multi-terminal lead-through and peripheral types are available. Each vacuum seal undergoes a pre-test with a high sensitivity helium mass spectrometer. This extra care gives added assurance that each and every part meets Sylvania quality standards.



• **Ceramic Parts Fabrication:** Alumina bodies ranging from 92% Al_2O_3 through 99% Al_2O_3 can be fabricated either by dry pressing, extrusion or machining processes. Forsterite, Zircon porcelain and Steatite compositions are available in an infinite variety of designs and can be fabricated to unusually close tolerances.

For further information on Sylvania Ceramics send for Sylvania's new brochure "Precision Ceramic Parts For Industry." Or call your Sylvania Parts Division representative.

SYLVANIA

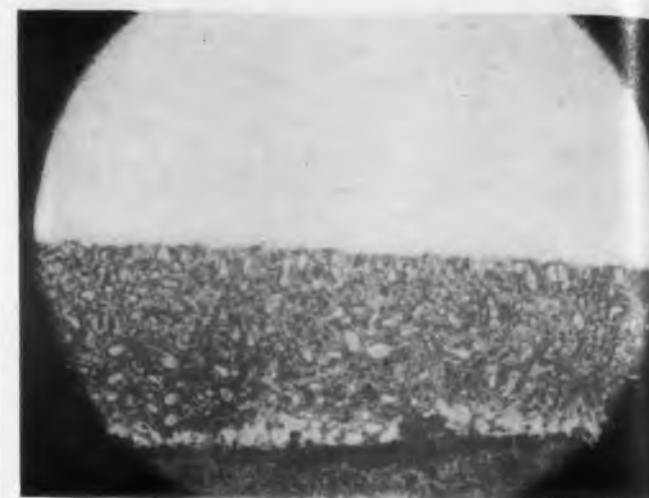
LIGHTING • RADIO • ELECTRONICS • TELEVISION • METALS & CHEMICALS

SYLVANIA ELECTRIC PRODUCTS INC.
Parts Division
1740 Broadway, New York 19, N. Y.



CIRCLE 332 ON READER-SERVICE CARD

Ideas for Design



Chemalloy solder welding magnified 100 times.

Aluminum Soldering

"Soldering" of aluminum castings, sheet and foil can be easily and economically accomplished without fluxing, using a noncorrosive joining material (zinc-lead blend). It develops tensile strength in excess of 50,000 psi, but melts at 800 F. Heat-treatable aluminum alloys may be joined with less damage to developed properties, due to the relatively low temperatures required.

In joining with the zinc-lead blend, presence of aluminum oxide is ignored. Surfaces should be clean, although this preference is not critical. Heat just sufficient to melt the joining material is applied to mating aluminum faces. Solder rod is flowed on and spreads immediately between joints by capillary action.

Samuel Freedman, Chemalloy Electronics Corp., Santee, Calif.



Soldering to an aluminum radio chassis using a modified blow-torch and Chemalloy solder.

Miscellaneous Ideas

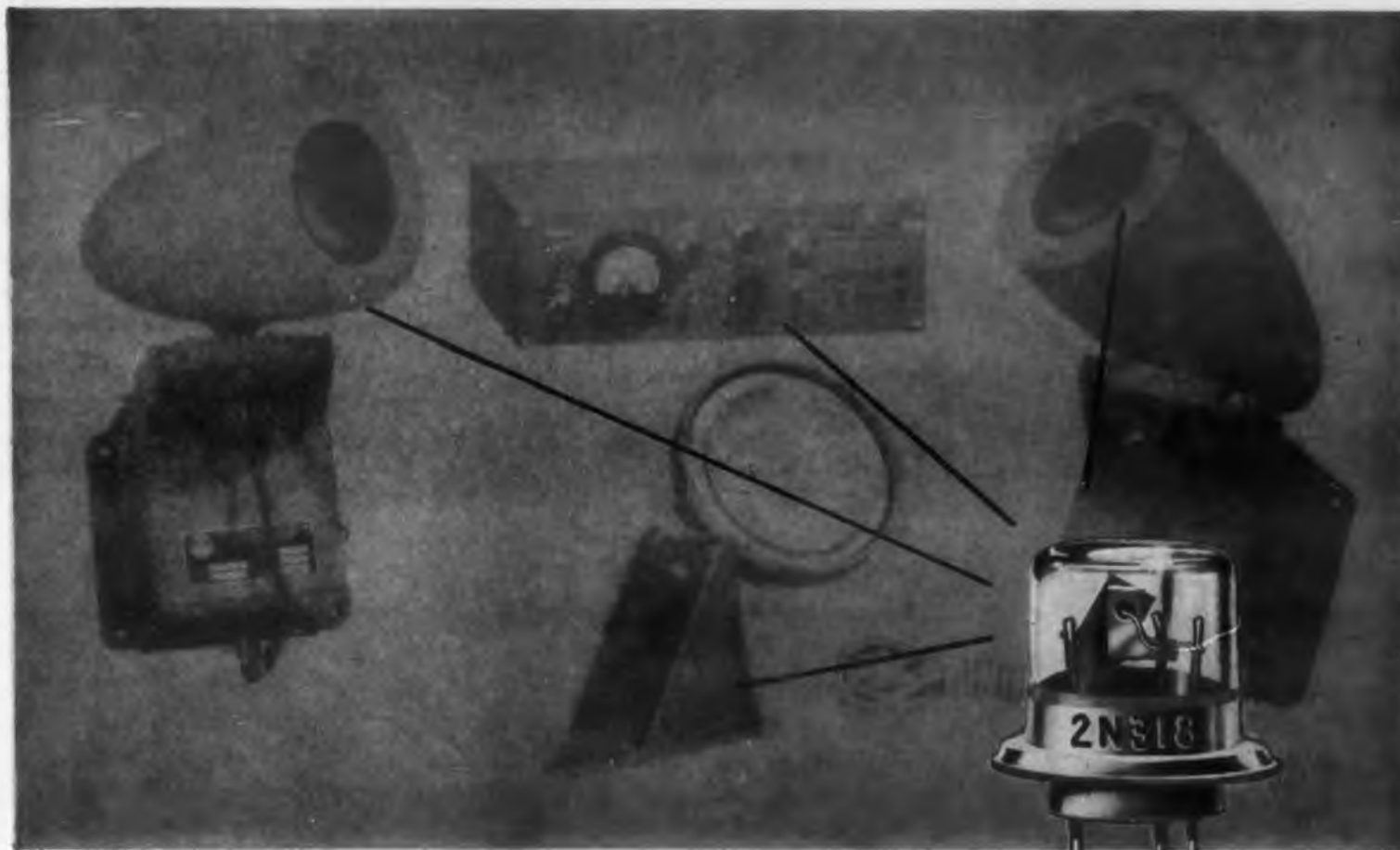
Samuel Freedman of Chemalloy Electronics Corp., San Diego, California has suggested the following ideas as developments that can be perfected in a short period of time. For details, the reader is referred to him at Gillespie Airport, Mantee, California (San Diego.).

1. Dry bearing metal which requires no coolant or lubricant when in friction with either metals or phenolics.
2. Soft low temperatures solders which will work with soldering iron as well as minimum torches to do either soft-soldering, or hard-soldering in competition with fluxless and flux type solder/welding rod in aluminum situations.
3. Metals to electrify and decompose liquids into hydrogen gas.
4. Metals to decompose liquids and remove them as gases for use as dessicants in competition with silica gel, requiring no dehydration system.
5. Metals in powdered form for planting in the soil with seeds to markedly reduce plant growing time by means of soil electrification and soil aeration through conversion of soil moisture into escapable hydrogen gas.
6. Liquid evaluator apparatus using chemalloy metal reference to analyze and evaluate liquids by electrical response on meter or recorder for analysis, food liquids, hydrology, etc.
7. Tuned microwave reflectors to eliminate null effects at boundaries of random reflectors and get large increase in signal strength with existing radar, microwave communication and TV antenna situations.
8. Generation of microwaves with conventional tubes by making the transit time equal to $\lambda/4$ or equal to an odd number of half periods of scillation.
9. Microwave fm modulators and devices which vary in accordance with changes in the equivalent of a loudspeaker voice coil cavity all to provide any choice of deviation ratio.
10. Self-charging and self-reviving batteries except for liquid replenishment. A wide family of capabilities obtainable by different electrolytes ranging from near 0v per grain of metal for petroleum to 1.1 v per grain of metal for chili peices with fresh water being half-way mark; 10,000 such charges per pound of metal.
11. New blends of metals with properties heretofore lacking by using the ability of the Chemalloy patented process to homogenize . . . or better homogenize and less heterogenize normally incompatible metal combinations.
12. Chemalloy, with 90 per cent zinc, can replace babbitt metal which has 90 per cent tin in case tin supplies are cut off from abroad in the event of an emergency.

GENERAL TRANSISTOR

SELECTED FOR RELIABILITY BY

Walter Kidde & Company



TRANSISTORIZED PHOTO-ELECTRIC ALARM

Features.. ELECTRONICALLY MODULATED BEAM

Walter Kidde engineers had the problem of designing a circuit that would be completely reliable even under severe operating conditions. Reduced size at a realistic cost was also of extreme importance. Kidde engineering designed a transistorized unit which completely eliminated vacuum tubes and the replacement and service problems which accompany them. This Model, #1100, is unaffected by line voltage variations from 95 to 130 volts and is easily serviced.

Walter Kidde made a thorough investigation of the market and, after extensive testing, selected the one transistor that was able to meet all physical, electrical and reliability specifications . . . General Transistor's Photo-Transistor 2N318/GT-66. This is just one more example why General Transistor is the fastest growing name in transistors.

Write today for complete technical information — Specification Sheet 2N318.

FOR IMMEDIATE DELIVERY FROM STOCK. CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 95-27 SUTPHIN BLVD. JAMAICA 35, NEW YORK

FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE JAMAICA 35, NEW YORK



GENERAL TRANSISTOR

C O R P O R A T I O N

91-27 138TH PLACE JAMAICA 35, NEW YORK

CIRCLE 333 ON READER-SERVICE CARD

100-VOLT TRANSISTOR...

New high power type available



Typical Characteristics at 25° C	DT100
Maximum Collector Current	13 amps
Collector Voltage, Emitter Open	100 volts
Saturation Voltage (12 amps)	0.7 volts
Power Dissipation	55 watts
Thermal Gradient from Junction to Mounting Base	1.2° C/watt
Nominal Base Current I_B ($V_{EC} = -2$ volts, $I_C = -1.2$ amp.)	-19 ma
Distortion (Class A ₁ , 10 watts)	5%

DELCO HIGH POWER TRANSISTORS

The electronics industry asked for a transistor to handle higher voltage—and here it is—Delco Radio's DT100 with maximum collector diode voltage of 100 volts. This is the highest yet, and it paves the way for a wide range of new applications. The new DT100 is an alloy junction germanium PNP transistor—normalized to retain its performance characteristics regardless of age. You can depend on the uniformity, reliability and high current handling capacity of the DT100, just as you have in the past on all of Delco Radio's High Power transistors. Write today for complete engineering data.

DELCO RADIO

Division of General Motors
Kokomo, Indiana

CIRCLE 334 ON READER-SERVICE CARD



Ideas for Design



Original fan design

New fan design

Fan Assembly Redesign Cuts Cost

The possibility of a better and less expensive fan guard to hold a motor and fan, for the drawing-in and circulating of filtered air in an electronic recorder-amplifier cabinet assembly, was recognized.

The original version provided for motor mounting only. It was made from 1/16 in. aluminum formed from a developed blank with four corner gussets spot welded in place. It was later decided that a fan guard was needed, and a unit of expanded steel was added.

A new steel wire cage design now replaces the above assembly. Costs contrast is as follows, in lots of 1000:

Original Design	
Mounting bracket	\$2.70
Guard	2.00
Caustic dip on bracket	.10
Cadmium plating guard	.10
Added assembly cost over new design	.10
	<u>\$5.00 Total</u>
New Design	
Tool charge total	\$940
Amortization over 1000 pieces	\$.94 each
Cost of manufacturing (including finish)	1.03
	<u>\$1.97 Total</u>
SAVING PER UNIT	\$3.03

There was close cooperation with the wire-forming company on a design to accommodate their methods—e. g. wherever possible multiple

points of weld which could be done at the time were made on a common plane. Sizes of wire selected were readily procurable, etc.

The smaller diam at one end of the new design enables these parts to be stacked during production handling and also requires less shipping volume and smaller storage area.

Less obstructions in air path due to new structure "open" construction resulted in improved air volume moved.

John R. Smith, Senior Mechanical Engineer, Sanborn Co., Waltham, Mass.

Protection for Printed Circuits

In order to protect delicate printed circuits from shipping and handling damage, they can be packaged in specially designed film bags made of polyethylene. For many radio and television printed circuits, a simple slip sheet suffices. But for highly sensitive quality circuits, where a slight scratch may cause distortions, the new bags are specified. The polyethylene film bags, which are furnished with a special dustproof and waterproof pressure closure, protect the parts from scarring during stacking and shipment. They also keep out moisture and dirt during storage. Flexible film made of polyethylene is highly resistant to moisture penetration. It is also resistant to cracking, peeling, hardening, or tearing. It retains its strength and toughness even at the subfreezing temperatures that are sometimes encountered in shipping. Clear film made of polyethylene permits visual inspection of parts. Standard bag sizes are 3 by 6 in. and 8 by 11 in. The film used is 0.004 in. thick. The special closure which seals with thumb pressure, can be easily opened when the part is needed (see photo). The bags are reusable.

Bakelite Co., Division of Union Carbide Corp., 260 Madison Ave., New York 16, N.Y.

PERFORMANCE PROVES CAPABILITY

INERTIAL GUIDANCE



KEARFOTT has been engaged in the development, production and flight testing of Inertial Systems and their components for over 7 years. Their leadership in the field of lightweight, high precision Inertial Guidance Systems for aircraft and missiles has been proved by performance. The instrument shown here is a typical KEARFOTT inertial platform.

CENTRAL GYRO REFERENCE SYSTEMS



Based on this 3 gyro, 3 gimbal stable platform weighing only 25 pounds, precise vertical reference (2 milliradians) under all dynamic conditions is guaranteed. This system also serves as an all-latitude compass system with 1° per hour random drift rate. Its performance is substantiated by the hundreds of systems in operation today.

LIGHTWEIGHT ALL ATTITUDE COMPASS AND VERTICAL REFERENCE SYSTEMS



Based on a 29.5 pound 3 gyro, 4 gimbal platform, Kearfott All Attitude Compass Systems provide continuous steering signals throughout a LABS maneuver. In addition to the compass features of the U.S.A.F. J4 System, precise vertical reference for fire control, autopilot and radar stabilization is available. Proved by 2 years' service in the field. Total system weight—57 pounds.

GREAT CIRCLE NAVIGATION COMPUTERS



Kearfott's great circle dead reckoning computer systems, continuously compute and display present position, course and distance to a primary and 3 alternate destinations, latitude and longitude of the destination points. Ground track is also indicated. Range: 2000 miles, speed range: 2000 knots. Extensive flight tests have confirmed the following accuracies: Present position—1 mile or 1/2% of distance traveled; Distance—1 mile or 1/2%; Course: 1/2°.

COMPONENTS:

Only the dependable accuracy of KEARFOTT Components have made the dependably accurate KEARFOTT Systems possible. KEARFOTT Components include Synchros, Servo Motors, Tachometers and computer assemblies. Their capability has been proved by years of satisfactory service in airborne fire control, autopilot, radar and navigation systems. Write today for descriptive technical data.



A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.; Midwest Office: 23 W. Calendar Ave., La Grange, Ill.; South Central Office: 6211 Denton Drive, Dallas, Texas; West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

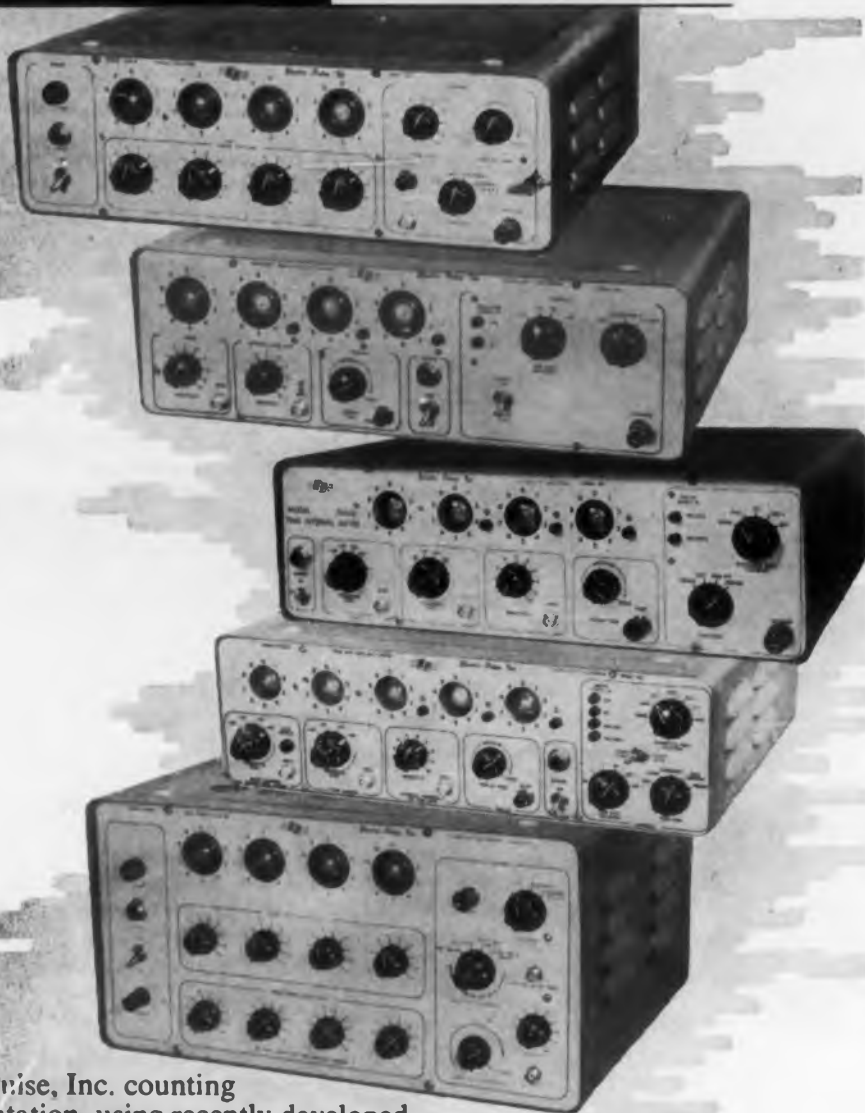
CIRCLE 335 ON READER-SERVICE CARD



a New Concept in

ELECTRONIC COUNTING EQUIPMENT

- Printed Wiring & Modular Construction
- Simplified Circuitry, Low Maintenance
- Self-testing, Self-indication
- Low Power Requirement
- Counter Tube Life: 10,000 hours
- Competitively Priced



Electro-Pulse, Inc. counting instrumentation, using recently developed self-indicating glow transfer tube counters, offers significant advantages in a wide range of measurement and control applications. Simplified circuitry and advanced design provide laboratory accuracy and industrial reliability.

Packaging features include snap-off top and bottom cabinet plates—for easy maintenance access and conversion to bench or relay rack mounting. Standard printed circuit modules utilized in this equipment may also readily be combined for OEM and other special test and control requirements.

Instruments available include single and dual preset counters, frequency indicators with and without print-out, time interval meters, totalizers, combination frequency and time interval indicators.

Contact local Representative for further information—or . . .

Write for Complete Data: Catalog IC-57/ED

Electro-Pulse, Inc. also offers a broad line of **precision pulse instrumentation**:

Pulse Generators, Time Delay Generators, Magnetic Core Testing Equipment, Pulse Code Generators, etc.

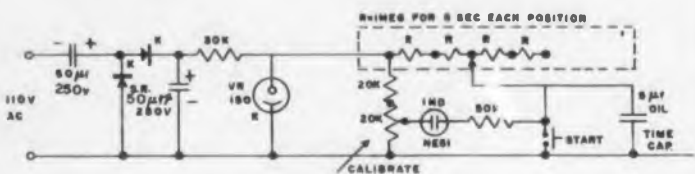
Write for Catalog 1-57/ED

EP *Electro-Pulse, Inc.*

11861 TEALE ST., CULVER CITY, CALIF. • Phone: EXmont 8-6764 or TEXas 0-8006
CIRCLE 336 ON READER-SERVICE CARD



Ideas for Design



Electronic Timer

Described is an electronic timer for use in a photographic darkroom or elsewhere. The timer needed to have a linear scale and a control providing a detent for each time interval.

The circuit shown provides a visual indication at the end of the elapsed time set by the control, which is a standard multi-position switch. If desired, a resistance decade can be used. When the start button is pressed and released, the timing capacitor begins to charge. When it reaches a value of 60 v, the neon lamp fires and provides indication of the completed cycle.

A more complex version of this circuit uses a cold cathode triode in place of the neon tube. Also, a relay could be used to control external circuits.

Jack Kouzoujian, Lamb-Electronic Development Labs., 141-17 59 Ave., Flushing, N.Y.

Plastic Tooling

Plastic tooling is proving the economical solution for many of the problems in the light-metal fabricating industry. Plastic compounds based on epoxy resins provide better tooling at lower costs and minimum downtime.

Arvin Industries, Inc., Columbus, Ind., makes a wide variety of light metal products in production quantities using glass-reinforced epoxy jigs and fixtures for quality control. Use of tooling compounds based on epoxy resins has provided drastic reductions in both costs and time. Close tolerances can be held in fabrication, and this dimensional stability is maintained throughout the life of the tool. These epoxy resins cure at room temperature, hold tightly to inserts, bond directly to backing structures, and adhere stongly to reinforcing materials.

Lightweight tools made with epoxy resins are easier to handle than conventional tools, which means less worker fatigue. They are less expen-

attention

idea men



Because an electronic design engineer must have hundreds of ideas to draw upon for each individual design decision, the editorial staff of *ELECTRONIC DESIGN* is continually trying to add to this storehouse of ideas. We are, therefore always interested in material based on your own experience which would be of immediate practical use to electronic design, development and research engineers. It is not difficult to write an article for *ELECTRONIC DESIGN* if you know what to write about and how we like to have our stories written. To simplify the preparation of an article, we have drawn up a brief guide for authors. Send for your copy today.

Edward E. Grazda, Editor



ELECTRONIC DESIGN

19 East 62nd Street
New York 21, New York

NOW! Accurate Functional Tests of Complex Relay Systems!



DIT-MCO Model 250F FUNCTIONAL TESTER

The Model 250F can automatically test the functional components and associated wiring of any complex relay system! The Functional Tester makes conclusive tests for continuity, continuity-discontinuity, discontinuity-continuity, insulation-resistance and shorts in relay systems involving switches, solenoids, actuators, resistors, etc. Features a timer for checking time-delay circuits and plugboard programming which permits efficient test planning and make-ready. Operation is easily mastered by non-technical personnel.

plus These features of DIT-MCO's famous CIRCUIT ANALYZER!

- **ELECTRONIC DETECTOR UNIT** . . . automatically tests quality to pre-set values!
- **TESTS UP TO 200 CIRCUITS** . . . in less than a minute!
- **MATRIX CHART** . . . pinpoints location and type of error automatically!
- **VACUUM-TUBE OHMMETER** . . . allows any circuit to be measured at any time during test!
- **UNIVERSAL** . . . adaptable to any relay system without modification!
- **STANDARD PARTS** . . . trouble free operation from telephone-type parts!

For additional information on the Model 250F or DIT-MCO Circuit Analyzers write:

DIT-MCO, INC.

ELECTRONICS DIVISION
Box 11-20, 911 Broadway
Kansas City, Missouri

CIRCLE 417 ON READER-SERVICE CARD

sive to build because of the elimination of costly machining and the simplification of many fabricating operations.

Epoxy tooling compounds can be cast or laid up to final shape in one operation. Since many conventional finishing and dovetailing steps are eliminated, tooling time and cost has been reduced 50 to 70 per cent on some time. On some production changeovers, Arvin was able to move forward with new tools produced over a weekend. Ordinarily, these same tools would require several weeks' delivery time.

Bakelite Co., Div. of Union Carbide & Carbon Corp., 260 Madison Ave., New York 16, N. Y.



An Arvin heater (lower right) made from epoxy resin tooling. Because of the many prototypes involved in its operations, plastic tooling speeds up production and lowers costs. One of the first steps in making a sample part is pouring of liquid epoxy compound around the wood model (top left). Glass cloth is used as a reinforcing material to give extra backing and strength (top right). The stamped face of the heater containing opening for controls is removed from the form (bottom left). Complete prototype heater with metal grill is shown (bottom right). Heater was built in about one-third the time required with conventional metal tooling. Other jobs which would normally require several weeks have been completed over a weekend. Epoxy tooling compounds are light in weight, extremely hard, and have high mechanical strength and impact and abrasion resistance. Close tolerances are possible with these compounds, and this accuracy is maintained throughout the life of the tool.

ALL GRADES MIL-I-631C VINYL INSULATION



EXCEEDED

by these **2** Resinite Sleeveings

Just two sleeveings—one source—can supply all your needs for every grade of MIL-I-631C vinyl insulation. Resinite EP-69A and Resinite Hi-Heat 105A not only meet every requirement, but far exceed specifications. Simplify ordering, reduce inventory with these two fine Resinite sleeveings.



EP-69A for low temperature and general purpose use. Wide working range from -48°C to 90°C . Dielectric to 750 volts/mil. Corrosion, oil, fungus and flame resistant. #20 AWG through $2\frac{1}{2}''$ ID. 5 standard colors, others available.



HI-HEAT 105A for high temperature use where outstanding resistance to heat and oils is required. For continuous operation from -21°C through 105°C . 1000 volts/mil average dielectric. Exceptionally high flame, fungus and cut-through resistance. #24 AWG through $2\frac{1}{2}''$ ID. 11 standard colors, others available.

Write us your requirements and we'll submit samples and performance data on appropriate sleeveings, tapes or lacing cords.

® Resinite



Resinite Department THE BORDEN COMPANY Chemical Division
Box 1589, Santa Barbara, California

SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS, ELECTRICAL AND PHARMACEUTICAL FIELDS

CIRCLE 338 ON READER-SERVICE CARD



attention
advertisers

COMBINATION RATES



Beginning January 1st, bulk and frequency rates will apply in combination to both *Electronic Design* and *Electronic Week*. The new rate structure makes possible even more efficient coverage of the two most influential segments of the e.o.e.m. — the design-engineering and executive-business groups. Now is the time to round out your marketing program with the expanded circulation offered by these prime interest publications.



HAYDEN PUBLICATIONS

New York 21: 19 East 62nd Street. TEmpleton 8-1940
Chicago 11: 664 North Michigan Ave. SUperior 7-8054
Los Angeles 36: 5720 Wilshire Blvd. WEstbster 8-3881

PRIME INTEREST PUBLISHING



Ideas for Design



Easily installed, the wood inset requires only a combination drilling and countersinking operation. A standard carpenter's drill with a shoulder type inserting tool is used for installation. Insert shows installation.

Wire Inserts for Wood Cabinets

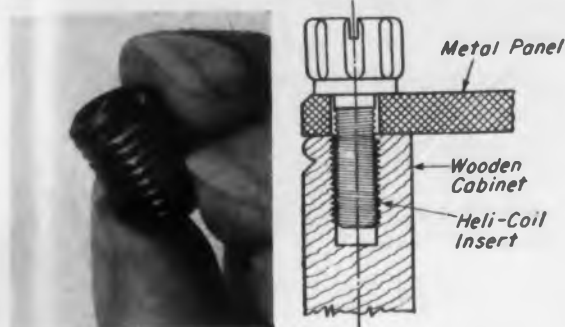
Wire thread inserts now replace bushings for strengthening screw threads in wood cabinets at General Radio Company, Cambridge, Mass. The electrical components of the instruments are supported by a metal panel which must in turn be fastened to the wooden cabinet.

Anodized aluminum thumbscrews, from four to eight per instrument, are used to attach the metal control panel to the cabinet. With the old-type bushings, splits often occurred in the cabinets. These Heli-Coil inserts have no wall thickness so do not require as large a hole in the wood as that required by solid bushings. That, together with the fact that the inserts are screwed into the wood rather than driven into it, has eliminated the splitting effect.

Another advantage of the insert is its ability to lock itself firmly in the tapped hole. The reinforcing insert thus locked in place does not back out when the thumbscrew is removed.

Insertion of the inserts in the cabinet is accomplished by drilling with a standard tap drill and countersinking. The inserts are then installed with inserting tools supplied by the insert manufacturer. The result is a tough, durable thread that will not back out and which does not split the cabinet. The inserts are manufactured by Heli-Coil Corp.

3M Chemicals opening new worlds of use for epoxies!



Self-tapping insert provides threads that will not strip or wear in wood, plywood, fiberboard, chipboard, laminates and other related materials. Cross section shows thread insert of stainless steel wire installed in 1/2 in. wood to receive thumbscrew. The insert requires less space than a solid bushing; eliminates possibility of splitting the wood.

Liquid "Lock-Washer"

The application of a liquid plastic called Loctite to ordinary threaded fasteners converts them to lock fasteners with a high resistance to loosening under vibration. Two methods of applying the Loctite sealant have been successfully developed for economical production use.

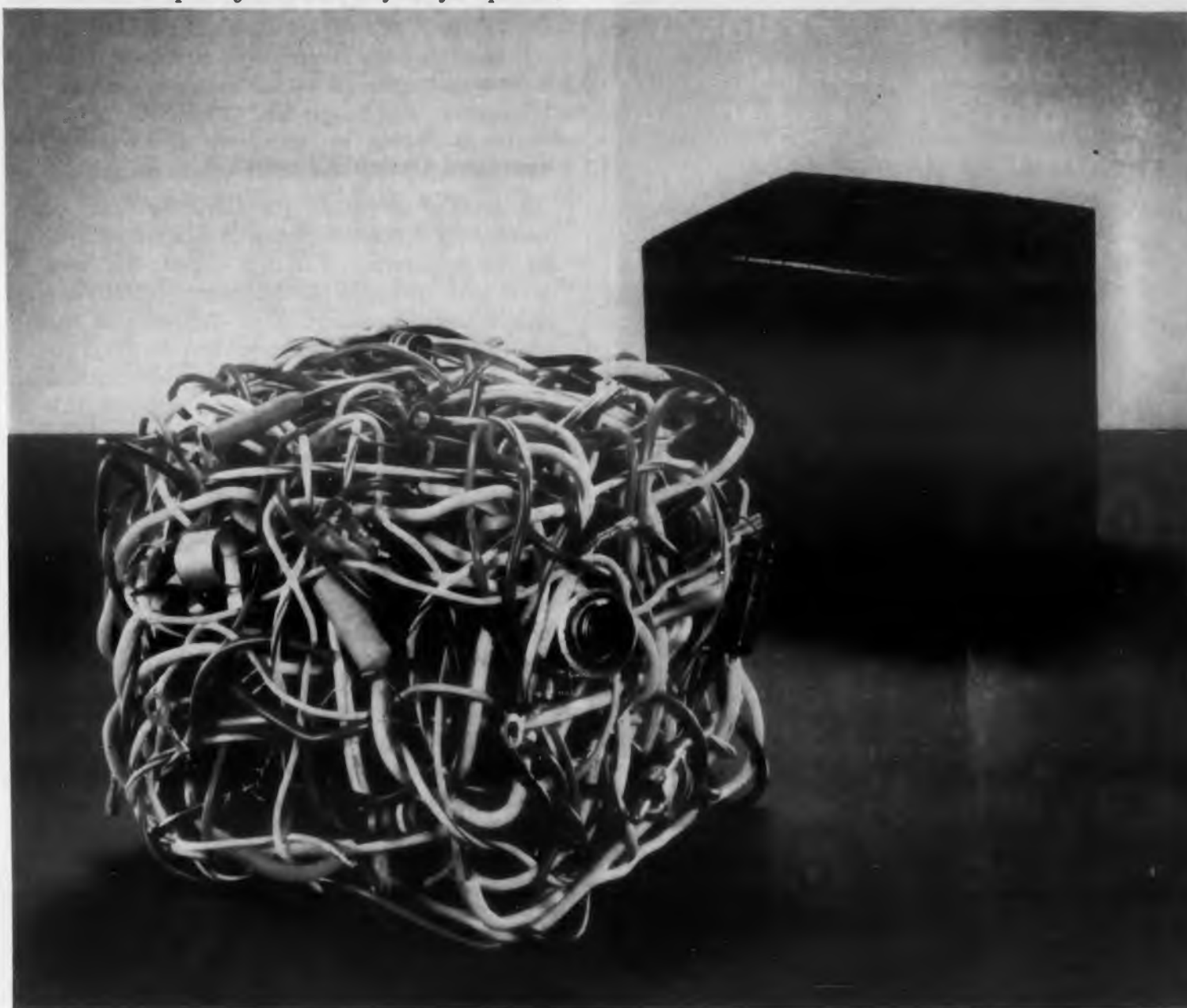
An applicator nozzle on the bottle permits the worker to carefully control the flow of sealant to nuts and bolts on a production line.

For screws, or externally threaded parts, Loctite sealant is most economically applied by tumbling in a polyethylene plastic bag. (See photo.) Loctite sealant hardens automatically between engaging threads to form a tough, resistant plastic that grips securely. Ordinary fasteners treated with Loctite sealant are gripped so securely that no amount of vibration will shake them loose, yet they can be removed with ordinary tools.

American Sealants Co., 103 Woodbine Street, Hartford 6, Conn.



Tumbling screws with loctite sealant (Homelite Plant, Port Chester, N. Y.)



You could even encapsulate shapes like this with epoxies flexibilized by... CARDOLITE® NC-513

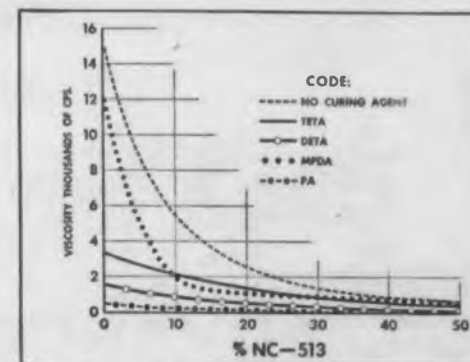
The key to encapsulating complex shapes in epoxies? It's low viscosity. That's why Cardolite NC-513 can help you flow epoxies around the most intricate electrical parts. This 3M epoxy resin flexibilizer has unusually low viscosity... **aids resin penetration, cuts risk of air entrapment to a minimum.** Or it lets you add more filler, cut cost but not exceed original resin viscosity.

The result? Cardolite NC-513 is opening new uses for epoxies daily. What's more, with Cardolite NC-513 you can

formulate any degree of resin flexibility you desire. And without loss of flexibility after extended high temperature operation.

Cardolite systems stay flexible permanently at both high and low temperatures. Electrical properties, chemical stability and age-resistance are excellent.

Where flexibility is essential, investigate Cardolite NC-513, made by Irvington Chemical Division of 3M. Write: 3M, Dept. WD-117, St. Paul 6, Minnesota.



Viscosity of typical NC-513 epoxy system

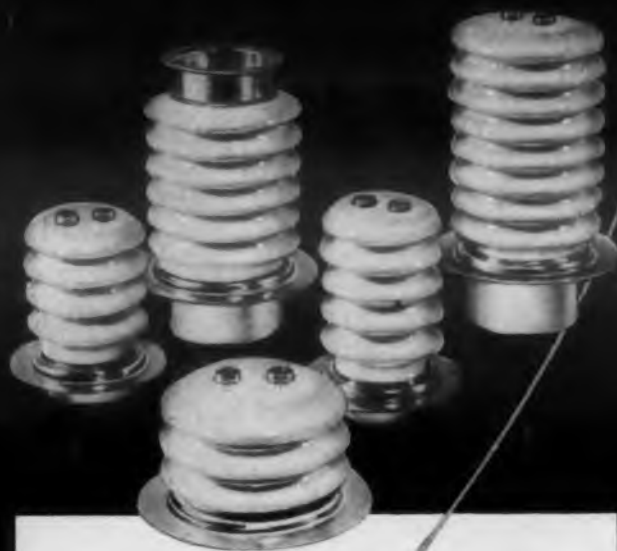
IRVINGTON CHEMICAL DIVISION • CHEMICAL PRODUCTS GROUP
MINNESOTA MINING AND MANUFACTURING COMPANY

... where Research is the key to tomorrow

CIRCLE 340 ON READER-SERVICE CARD



Terminal breakdown problems solved on airborne radar transformers . . .



with ADVAC
HIGH-TEMPERATURE, HIGH-VOLTAGE
TERMINALS

Today's aircraft fly at faster speeds and higher altitudes, causing components to undergo extreme temperature change and mechanical shock. In addition, high brazing temperatures weaken glass type seals, resulting in a high reject rate. Installation of ADVAC alumina sealed terminals solved the problems completely. These super-strength terminals are immune to thermal shock, offer highest mechanical strength and are adaptable for brazing, welding and soft soldering. Maximum operating voltage is 6500 V.

Complete information and catalog available on request. Please address inquiries to Department

ADVAC Terminals are Products of—

**ADVANCED
VACUUM
PRODUCTS • INC**

430 Fairfield Avenue, Stamford, Connecticut
Telephone: DAVis 4-2148

A DIVISION OF GENERAL CERAMICS CORPORATION
CIRCLE 341 ON READER-SERVICE CARD

Report Briefs

Improved Optical Cement

A method of raising the softening point of commercial cellulose caprate to a level suitable for the preparation of optical cement has been developed. In earlier developments of cellulose caprate optical cement, it was found that the addition of certain plasticizers to raw or as received commercial caprate improved optical properties by raising the refractive index. This addition also lowered the softening point of the batch, and the cement failed to meet the shear test specifications. The corrective technique consists of the partial hydrolysis of the ester by means of aqueous hydrochloric acid-methanol mixtures. The increased softening point of the caprate enables its use in a standardized manufacturing process, and assures a satisfactory optical cement. This report also discusses the changes in cellulose caprate during hydrolysis, and methods for analysis of small quantities of hydroxyl groups in cellulose esters. *Hydrolytic Modification of Cellulose Caprate, D. E. Field and R. B. Fox, Naval Research Laboratory, May 1957, 7 pp, \$0.50. Order PB 131021 from OTS, U. S. Dept. of Commerce, Washington 25, D.C.*

Noise Measurement

This report covers the development of an experimental model radar performance monitor that would be capable of continuously monitoring system performance, as indicated by the parameters of receiver noise figure, transmitted power, and transmission line swr. The monitor is ultimately intended to be part of an unattended radar system. In the event of radar failure, the monitor will provide information to the radar control circuits to initiate automatic radar channel transfer to secondary standby radar equipment. Some of the specific items that were accomplished under this contract are the design of a practicable noise figure monitor, two practicable methods for continuous monitoring of swr, and the design of a directional coupler assembly for use with the noise figure, power, and swr monitors. *Development of Noise Figure Measuring Equipment and Power SWR Monitors, C. W. Steele, Stanford Research Institute, July, 1956, 89 pp, microfilm, \$4.80, photocopy \$13.80. Order PB 124712 from Library of Congress, Washington 25, D.C.*

**I made these etched,
anodized metal name
plates right here
in our plant in
7 MINUTES
FLAT!**



"The boss heads R & D. Everything's SPEED here with a Capital 'S' . . . When we need metal panels, dials, name plates we need 'em NOW, not tomorrow . . . That's why the boss got this amazing Fotofoil Kit, put out by Miller Dial. He took me off a typewriter, and an hour later I was batting out professional quality etched and anodized metal name plates. No darkroom, no special equipment — just me, my Fotofoil Kit and a table in the corner! . . . Mister, why don't you get a Fotofoil Kit — you'll be glad you did."

TYPICAL USERS:
Hughes Aircraft Co.
Lenkurt Electric Co.,
Inc.
Chrysler Corp.
Lear, Inc.
O'Keefe & Merritt
Berkeley Scientific
Corp.

P.S. We have territories open for responsible Industrial Suppliers.

Write Department ED-11

MILLER DIAL AND NAME PLATE CO.

4400 N. Temple City Blvd. El Monte, California
Offices in principal cities

CIRCLE 389 ON READER-SERVICE CARD

molded
Black Nylon
screws
and nuts

Insulate and Fasten
without bushings,
washers, etc. In Stock
4-40, 6-32, 8-32,
10-32 and 1/4-20.



Black Nylon
"NyGrip"
cable
clips

Light-weight non-
conducting support
for wiring, tubing, etc.
In Stock 1/16" to
1/2" Dia.

Free samples • write **WECKESSER CO.**

5703-05 Northwest Hwy., Chicago 30, Ill.

CIRCLE 342 ON READER-SERVICE CARD

Kester Solderforms will give you today's demanded economy plus end product quality greater than ever before.

Write For Complete Information

KESTER SOLDER COMPANY

4266 Wrightwood Ave. • Chicago 39, Ill.
Newark 5, N. J. • Brantford, Can.

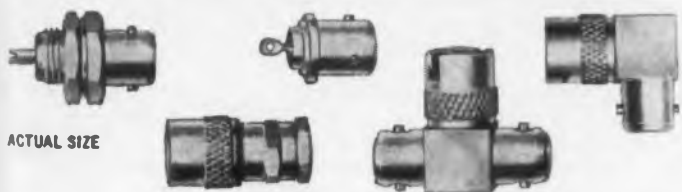
CIRCLE 343 ON READER-SERVICE CARD

MINIATURIZED EQUIPMENT GROWS SMALLER STILL

with

DAGE DM series
RF Cable Connectors

half the size of standard BNC's



- Tiny but rugged, can withstand a cable pull of over 50 lbs.
- Twelve polarity groups—two and three lug
- Vibration-proof bayonet locking (MIL-C-5015)
- Teflon insulators permit use over wide temperature-range with low electric loss
- .002" silver plate and gold flash affords excellent corrosion resistance

Dage Catalog 201-B gives full details with specifications on sub-miniature DMs. Write for your free copy.

DAGE ELECTRIC CO., INC. 67 No. Second St.
Beech Grove, Ind.

CIRCLE 344 ON READER-SERVICE CARD

Reliability Design Guides

Twelve simple guides for the design of reliable electronic equipment are contained in a volume prepared for use by electronic engineers and technicians. The report was compiled for guidance in the design of ground based data gathering and data assessing equipment, but it contains information useful to other types of electronic devices. The guides were based on studies of the effects of increased equipment complexity, distribution of causes of equipment failure, technique of reliable design, and selection of components. Such tube reliability factors as filament current surges, cathode interface formation, tube envelope temperatures, new cathode designs, and the use of special tubes also were considered. *Twelve Guides to Reliable Electronic Design*, G. G. Johnson, U.S. Naval Ordnance Laboratory. Apr. 1955, 57 pp, \$1.50. Order PB 121123 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

Printed Wiring Techniques

This report reviews the present state-of-the-art with emphasis on printed wire manufacturing processes, printed wire board materials, and design considerations of printed wiring such as the use of double sided laminates and assembly techniques. Information regarding the capabilities and limitations of printed wiring is presented plus a description of the RADPC printed wiring facility. Benefits that can accrue from the use of various printed wiring techniques are also given. *Printed Wiring Techniques*, Michael P. Forte and Harvey Shapiro, U. S. Air Force, Griffis Air Force Base, Rome, New York. June 1956, 46 pp, micro-film \$3.30, photocopy \$7.80. Order PB 124505 from Library of Congress, Washington 25, D. C.

Measures Set Thrust

This memorandum presents a method developed for continuously measuring and recording the thrust of pulse jet engines. The exposition of the method offered herein includes the design of a pulse jet engine suspension system, the design of a thrust sensitive linkage, and the results of some test runs. In this developmental work, a Dyna-jet engine served as a pilot model prior to full-scale investigations. *Applications of Dynamic Strain Gages to the Measurement of Continuous and Average Thrust of Pulse Jet Engines*, Paul Torda, Walter Ira Weiss, Erich Shatzki and Joseph Lovingham, Polytechnic Institute of Brooklyn, N.Y., Sept. 1948, 21 pp, \$.75. Order PB 13149 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

In Modern Design

Koiled Kords

play an important part

The use of KOILED KORDS retractile cords on more and more communications and industrial equipment in the past ten years has proved their claim of safety and convenience.

Designers have found KOILED KORDS invaluable in solving many wiring problems.

CAN YOU USE
KOILED KORDS?

Our years of experience with KOILED KORDS is available to you, without obligation, for help in solving your wiring problems.

Write for catalog today.



KOILED KORDS, THE ORIGINAL RETRACTILE CORDS, ARE THE RESULT OF 17 YEARS OF RESEARCH, DEVELOPMENT AND USE.

KOILED KORDS is a trade mark of Koiled Kords, Inc.

CIRCLE 345 ON READER-SERVICE CARD

HERE IT IS! AN AMAZING, NEW

HEMINWAY
& BARTLETT



NYLON "SUPER" LACING TAPE

ALL THE ADVANTAGES OF A TAPE...
IN THE PRICE RANGE OF A CORD!

- FUNGUS-PROOF
- STRONGER
- CAN'T CUT WIRES OR HANDS
- TIES EASY, FAST AND TIGHT
- KNOTS WON'T SLIP
- ECONOMY PRICED

FREE! Write today for free samples. In resin-coated finish.

The Heminway & Bartlett Mfg. Co., ELECTRONICS DIVISION, 500 5th Ave., N. Y. 36 Sales Offices: Chicago, Philadelphia, Boston, Cincinnati, San Francisco, Los Angeles, Detroit, Charlotte, N. C., Gloversville, N. Y., Lynchburg, Va. Foreign Agent: Turner, Halsey Co., Inc., 40 Worth St., N. Y.

CIRCLE 350 ON READER-SERVICE CARD

Time-Shared Videos

A Navy type SPA-8A radar plan-positioned indicator was modified to display two synchronized radar-video inputs on a time-shared basis. A characteristic of these radar inputs was that they possessed common or synchronized triggers and either synchronize antenna rotation. This report outlines two applications for this type of indicator and the modification and factors to be considered when time-sharing. Prepared for the Air Navigation Development Board under project no. 1.4. CAA TDR 290. *PPI Presentation of Time-Shared Videos Having Synchronized on Unsynchronized Antenna Rotation Rates*, William E. Miller and Lawrence B. Li, U. S. Civil Aeronautics Administration, Indianapolis, Ind. June 1957, 7 pp. \$0.50. Order PB 131137 from OTS, U. S. Dept. of Commerce, Washington 25, D. C.

Airways Electronics Maintenance System

Findings are presented of a field survey of the new Airways and Air Communications Service maintenance system. With each finding is presented a brief analysis where appropriate, and a recommendation for alleviating difficulties found. Recommendations are made for a strong OJT program, for modifications to present maintenance guides, procedures, and equipment, and for studies to determine: (a) what are minimum routine maintenance requirements, (b) what are the practical maintenance data needs of the command, and (c) what is the optimal content and form of checklist-type maintenance guides. *Survey of the Airways and Air Communication Service Electronics Maintenance System*, Paul Spector, American Institute for Research, Inc., Pittsburgh, Pa. June 1955, 28 pp, \$2.70, photocopy \$4.80. Order PB 124734 from Library of Congress, Washington 25, D. C.

Ionized Gas Study

The state of a plasma is described by phase space distribution functions for the electrons and ions. A derivation of this set of equations based on Liouville's theorem is presented. A class of time independent problems is considered in which the set of equations may be reduced to two or three coupled ordinary differential equations. The method is applied to problems of the confinement of a plasma by a magnetic field, the pinch effect, and nonlinear plasma oscillations. *On a Self Consistent Field Method for a Completely Ionized Gas*, E. G. Harris, U.S. Naval Research Laboratory. May 1957, 21 pp, microfilm \$2.70, photocopy \$4.80. Order PB 125388 from Library of Congress, Washington 25, D.C.

Specify standard **FLEXLOC** microsize locknuts



- One-piece, all-metal construction
- Resilient locking section
- Controlled locking torque
- Lock and stop nut in one
- Every thread carries its full share of the load
- Made to Class 3B fit

Smaller than regular FLEXLOCs of the same nominal diameter, FLEXLOC microsize locknuts make possible smaller mating joints and flanges. Standard materials are brass (plain or cadmium plated) and aluminum (plain or chemically treated), for temperatures to 250°F; alloy steel and 18-8 stainless steel, for temperatures to 550°F. They are available in sizes #0 through #4 at your industrial distributor's. See him for details. Or write for literature, samples, information on other materials. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 12, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

CIRCLE 352 ON READER-SERVICE CARD



RIGHT data—
RIGHT ideas—
to fill your

MINIATURE LIGHTING NEEDS

For Pilot—Dial—Indicating—Illuminant uses, DRAKE's quick-reference catalog simplifies selection of just the right Miniature Lighting unit. 16 picture and fact-packed pages include detailed specifications; plus highly useful data on basic unit elements, best choices for various uses, etc. *Project Data Sheet* makes it easy to get specific recommendations for your job. Decades of specialized experience in all aspects of Miniature Lighting make DRAKE first choice for top results, best quality, greatest economy.

SEND FOR YOUR COPY!



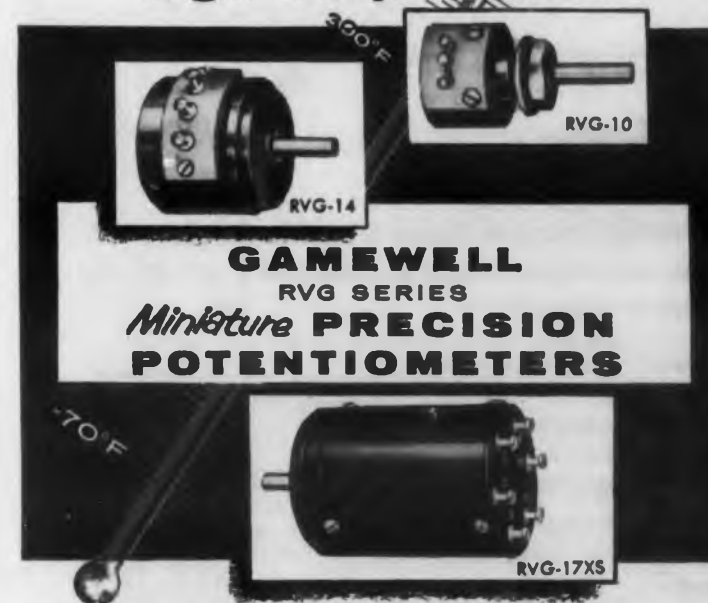
DRAKE

MANUFACTURING COMPANY
1711 WEST HUBBARD ST. • CHICAGO 22, ILL.

MINIATURE LIGHTING SPECIALISTS

CIRCLE 351 ON READER-SERVICE CARD

For Small Spaces, High Temperatures



GAMEWELL RVG SERIES Miniature PRECISION POTENTIOMETERS

These Gamewell pots — 1/4", 3/8" and 1 1/4" — provide superior characteristics in miniature size... ideal for high temperatures and other environmental extremes. All have anodized aluminum bodies, stainless steel shafts, excellent linearity and meet MIL-E-5272A specs as they apply. RVG-17XS has a specialized arrangement which produces sine-cosine functions with unique precision and smoothness.

For dependable performance under rugged environmental conditions and severe space restrictions, specify one of these RVG Precision Potentiometers. Many special features and modifications are also available to meet your specific need. Write or call for details.

THE GAMEWELL COMPANY, NEWTON UPPER FALLS 64, MASS.



PRECISION
POTENTIOMETERS

SPECIAL! Send for New catalog with data on complete line.

CIRCLE 353 ON READER-SERVICE CARD

Comar
relays
fit your
product
like a glove...



THEY FIT *electrically*
THEY FIT *mechanically*
THEY FIT *economically*

• Every Comar relay is custom-designed exactly to fit your requirements. It has precisely the electrical characteristics, the physical size, the mounting, demanded by your specifications. Yet, this "custom-fitting" costs no more than ordinary relays. Inquiries invited.



3349 ADDISON ST., CHICAGO 18, ILLINOIS

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING
CIRCLE 354 ON READER-SERVICE CARD

This is a
photosensitive
resistor... actual size



It's called a Kodak Ektron Detector, the photosensitive substance is lead sulfide, and it can be laid down in any pattern.

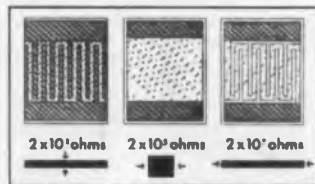
• Signal response extends from 0.25 microns in the ultra-violet to 3.5 microns in the infrared with maximum sensitivity at 2.2 microns in the infrared.

• They are available in complex and exact arrays and mosaics.

• Signal-to-noise ratio is excellent, particularly in the infrared.

• Vibration doesn't affect them.

• Elements can be extremely small in size.



To get the details on Kodak Ektron Detectors, write for a free booklet to: Military and Special Products Sales,

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Kodak

CIRCLE 355 ON READER-SERVICE CARD

Report Briefs

Design Methods for Mag Amps

This manual was prepared primarily for inexperienced designers of magnetic amplifiers. It contains step by step design methods for the standard amplifier circuits. Basic full wave circuits of the center tap, doubler, and bridge connections are discussed, along with some of the more recent half wave circuits. Theory of operation of each circuit is presented, including the function of the core and rectifier components and the effects of their properties on amplifier response. A section is devoted to design procedures for the different circuits, and another discusses construction materials and testing procedures. *Design Methods for Magnetic Amplifiers and Saturable Reactors, J. R. Walker and M. Frank, Wayne Engineering Research Institute for Wright Air Development Center, USAF. July 1956, 628 pp, \$9.50. Order PB 121765 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.*

RF Shielded Rooms

This report describes research which led to development of the Takedown Cell-Type Screen Room, an improved enclosure for suppression of rf interference, produced and used by industry today. The applied theory of shielding is presented in a form suitable for use in calculating the effectiveness of various types of shielding metals. Shielding effectiveness information is provided for frequencies as low as 60 cps. A detailed test method is provided for measuring the shielding effectiveness of enclosures over the entire rf spectrum, and in the presence of magnetic fields, electric fields, or plane waves. Also listed in the report are typical costs on the various types of shielded enclosures and power line filters, and the commercial suppliers of the enclosures. Among the uses described for the screen room is the rf calibration and alignment of electronic equipment. Rf susceptibility of equipment can also be determined and spurious radiation of receivers and transmitters tested. Of particular interest to industry, the enclosures can be applied to production testing and quality control of electronic devices. *Theory, Design, and Engineering Evaluation of Radio Frequency Shielded Rooms, C. S. Vasaka, U.S. Air Development Center. Aug. 1956, 120 pp, \$3.00. Order PB 121927 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.*



Springs

ENGINEERED FOR YOUR PRODUCT

The right spring will give you better performance. Consult our design specialists while your plans are in the formative state — for anything from a spring, to a wire form or small stamping. Send for your copy of "Spring Design and Selection — in brief."

ASSOCIATED
SPRING
CORPORATION



General Offices: Bristol, Connecticut
CIRCLE 356 ON READER-SERVICE CARD



Direct-Reading V-H-F Impedance Bridge to Measure Antennas, Lines, Networks and Components

Reactance Range: ± 200 Ohms at 100 Mc.
Dial range varies inversely with frequency, and is calibrated at 100 Mc.

Resistance Range: 0 to 200 Ohms, independent of frequency.

Basic Accuracies: Resistance $\pm(2\% + 1 \text{ ohm})$;
Reactance $\pm(5\% + 2 \text{ ohms})$.

Terminals for both coaxial and lumped circuit measurements.

Type 1601-A V-H-F Bridge: \$520.00

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

Broad Avenue at Linden, Ridgely, N. J. NEW YORK AREA 1000 N. Seward St. LOS ANGELES 39
8055 13th St. Silver Spring, Md. WASHINGTON, D. C. 1150 York Road, Abington, Pa. PHILADELPHIA
1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO 6605 W. North Ave., Oak Park, Ill. CHICAGO

In CANADA: 99 Floral Parkway, TORONTO 18

CIRCLE 357 ON READER-SERVICE CARD



ARNOLD TOROIDAL COIL WINDER

sets up quickly... easy to operate...
takes wide range of wire sizes

SPECIFICATIONS:

- Min. finished hole size: .18 in.
- Max. finished toroid O.D.: 4.0 in.
- Winding speed: 1500 turns/min.
- Wire range: AWG 44 to AWG 26
- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: 1/4" I.D. to 4" O.D. to 1 1/2" high

LABORATORY USE

- Change wire and core size in 45 sec.

PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

PRICE: \$1200 includes all rings, counters and accessories

IMMEDIATE DELIVERY. Literature on request
ARNOLD MAGNETICS CORP.
4615 W. Jefferson Blvd., Los Angeles 16, Calif.
REpublic 1-6344

CIRCLE 358 ON READER-SERVICE CARD

DESIGNERS

for COMPARATIVE AND
ULTIMATE STRENGTH
TESTS, ETC

INSPECTION

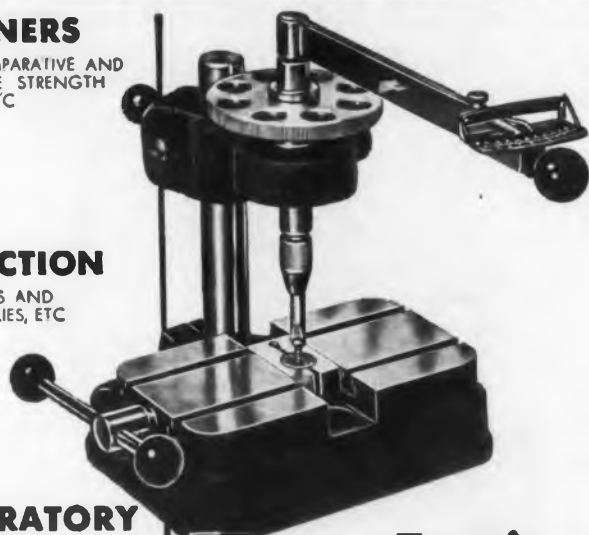
of PARTS AND
ASSEMBLIES, ETC

LABORATORY TESTING

of SCREWS
SOCKETS
TAPS
LOCK NUTS
DRIVING BITS
HAIR SPRINGS, ETC

PRODUCTION QUALITY CONTROL

for DELICATE OPERA-
TIONS, ASSEMBLY OF
FRAGILE MECHANISMS
ON INSTRUMENTS; FOR
FASTENERS IN PLASTICS
AND LIGHT METALS.



Torque Testing FIXTURE

A universal fixture with 1000 uses. Holds driver in accurate alignment; in instrument bearings. Provides rapid engagement with test sample...torque is applied and measured with Sturtevant Torque Wrench.

Model TTF 1/4 Capacity 0-200 in. lbs.
Model TTF 1/2 Capacity 0-150 ft. lbs.

Write for Bulletin TF

PA. **STURTEVANT CO.**
ADDISON [QUALITY] ILLINOIS

CIRCLE 359 ON READER-SERVICE CARD

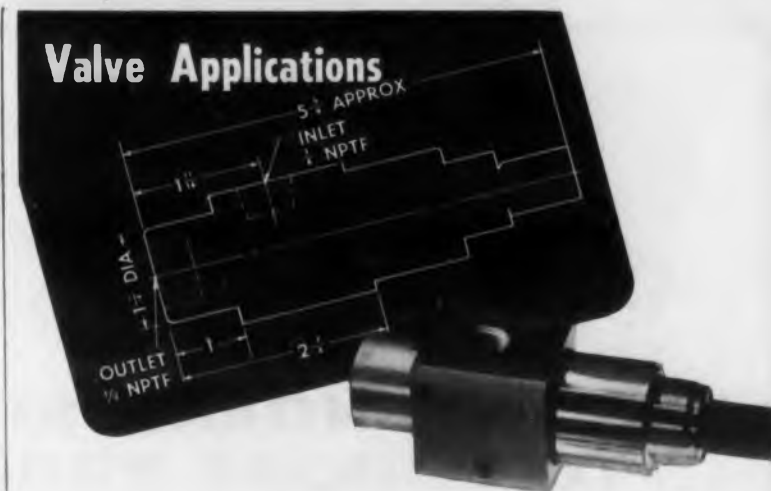
Mixing Theory Applied to Radio Scattering

Obukhoff's statistical theory of turbulent mixing is proposed as replacement for the heuristic theories of Galley and Villars-Weisskopf, and is applied to the problem of the scattering of radio waves by refractive index fluctuations. In the case of ionospheric scattering, order-of-magnitude agreement with the observed scattered power is obtained if the refractive index fluctuations are attributed to electron density fluctuations produced by turbulent mixing in the lower edge of the E-layer. In the case of tropospheric scattering, it appears that order-of-magnitude agreement with the observed scattered power can be obtained, except during the summer months, by attributing the refractive index fluctuations to temperature fluctuations. During the summer months and at low scattering heights, humidity and its fluctuations are expected to play a prominent role. Experimental and theoretical evidence is cited in favor of perennial fractional-degree temperature fluctuations in the troposphere. Comparison of the Obukhoff, Villars-Weisskopf, and Booker-Gordon models is given. *Turbulent Mixing Theory Applied to Radio Scattering*, Richard A. Silverman, New York University, New York, N.Y. Jan. 1956, 24 pp, microfilm \$2.70, photocopy \$4.80. Order PB 123409 from Library of Congress, Washington 25, D. C.

Cloud Refractive Index Studies

Certain radio and radar systems are affected by the inhomogeneities in atmospheric refractive index that occur in and around clouds, primarily the cumuliform type. This research was aimed at an expanded knowledge of the refractive characteristics of clouds and how these characteristics change with the meteorological factors that govern cloud birth, growth, and decay. The results were to be used in better system design and system operation predictability. It was concluded that the fluctuations of refractive indexes in and around clouds are qualitatively explainable, using existing hypotheses of cloud physics and dynamics. Total change in index form inside to outside the cloud agrees well with theory. The study included special problems inherent in measurement of refractive index and various theories of cumulus convection. The complex character of refractive index changes is tentatively explained. *Cloud Refractive Index Studies*, R. M. Cunningham, V. G. Plank, and C. M. Campen, Geophysics Research Directorate, ARDC, USAF. Dec. 1956, 137 pp, \$3.50. Order PB 131135 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

Valve Applications



Here is a high flow, low pressure fuel valve which handles 560 pounds per hour of fuel flow at an inlet pressure of 30 psi. with a 1 psi. pressure drop. Another example of the versatile family of electro-mechanical devices developed and precision produced by Koontz-Wagner, this valve operates in a -65° to 250° F. ambient range at 17 to 30 volts DC. Special application valves, solenoids and switches designed, developed and produced by Koontz-Wagner may have the answer to your problem. Write now to:

MANUFACTURING DIVISION

KOONTZ WAGNER
ELECTRIC COMPANY INCORPORATED

517 N. MICHIGAN ST. • SOUTH BEND, INDIANA
CIRCLE 360 ON READER-SERVICE CARD



HEAT-CONTROL PROBLEMS
IN YOUR INDUSTRY,
MR. DESIGNER?

BEST ANSWER USUALLY COMPACT, TOUGH,
ACCURATE FENWAL THERMOSWITCH UNIT

WE HAVE PROVED THAT TO DESIGNERS
IN ALMOST EVERY INDUSTRY,
INCLUDING, PROBABLY, YOURS.

VERY ADAPTABLE — 24,000 VARIATIONS
AVAILABLE ON BASIC THERMOSWITCH IDEA

Designers — Write Fenwal Inc.,
1711 Pleasant St., Ashland, Mass.,
for THERMOSWITCH Folder.

Fenwal

Controls Temperature
... Precisely

CIRCLE 361 ON READER-SERVICE CARD



*deep drawn
aluminum
boxes and
cases*

1400 STANDARD SIZES TO CHOOSE FROM

with no tooling cost!

Choose from more than 1400 standard sizes and save tooling cost. All can be trimmed and modified to your specification by secondary operations...brackets and fasteners installed, holes and louvers punched, welding, painting, etc. Choose from rectangular, round, square boxes and covers. Custom deep drawn parts at nominal cost using exclusive ZERO-method tooling—send your print or contact your local ZERO representative for a quotation.



Write for
complete new
ZERO catalog



ZERO MANUFACTURING COMPANY

1121 CHESTNUT, BURBANK, CALIFORNIA

CIRCLE 362 ON READER-SERVICE CARD

Linearity

better
than
0.0025%



WITH
ESI
MODEL
RV-622

DEKAVIDER®
decade voltage divider

specifications

INPUT RESISTANCE: 10,000 ohms
LINEARITY: $\pm 0.0025\%$
RESOLUTION: 0.0001%
MOUNTING: 19" x 3½" panel for
standard relay rack.
PRICE: \$395.00

For complete information, contact
your nearest ESI representative or . .

A precision Kelvin-Varley
voltage divider for rack
mounting, employing six
decades of resistors, closely
matched for highest accuracy.
Linearity specification applies
from d.c. to approximately 1
kc. Phase shift is about one
degree at 10 kc.

**ELECTRO-
MEASUREMENTS, INC.**

7524 S. W. MACADAM AVENUE
PORTLAND 1, OREGON

esi

CIRCLE 363 ON READER-SERVICE CARD

Patents

Failure Indication in Relay Communication Systems

Patent No. 2,802,898. Kenneth M. MacDowell. (Assigned to Raytheon Manufacturing Company)

The circuit is directed to a communication chain of relay stations with each station having a receiver and transmitter and with the output of the receiver modulating the output of the transmitter. The receiver includes an amplifier, the output of which is fed-back to the input of the amplifier when the input to the receiver is below a given value. The feed-back path includes a phase shifting means which causes the amplifier to oscillate at a predetermined frequency. The output of the transmitter is modulated with the output of the receiver. An indicator at the receiver of a succeeding station of the chain indicates the frequency at which the amplifier is oscillating.

Signal Voltage Amplitude Limiter

Patent No. 2,802,167 James M. Cooper (Assigned to General Electric Company)

The circuit is to be used to limit the amplitude of an amplitude modulated alternating signal voltage of predetermined frequency and wave shape without distorting the wave shape. The signal voltage is supplied to a pair of output terminals. A pair of diodes are provided across the terminals in oppositely poled parallel circuit relation. Opposite pulsating unidirectional biasing potentials are supplied between one terminal of each of the diodes and one of the output terminals which potentials are synchronized with half cycles of the signal voltage. These biasing potentials are of constant peak amplitude and have a pulse frequency equal to twice the predetermined frequency and a pulse shape substantially the same as the predetermined wave shape.

the A. W. HAYDON COMPANY'S ELAPSED TIME INDICATORS

measure a  of time... for

**INDUSTRIAL,
AIRCRAFT
and
MILITARY
applications**

Preferred
Where
Performance
is
Paramount



7500 Series Reset Type Elapsed Time Indicator. Send for Bulletins: AWH ET601. Reset Type Elapsed Time Indicators 7500, 12500, 24200 Series.



7500 Series DC Elapsed Time Indicator. Send for Bulletins: AWH ET600. Basic Elapsed Time Indicators 7500, 12500, 24200 Series.

Now the Company offers a complete line of timing motors and devices to record the operating time of any electrical or electronic equipment. Compact, minimum weight, each unit has five digits. They can be used to provide daily running time plus a total running record, eliminating estimating or manual totalizing. In both AC and DC, continuous or manual reset for 50 or 60 up to 400 cycle line frequency. Will measure hours or on down to 10ths of seconds. All models can be supplied with Radio Interference Filtering, to meet MIL-1-6181B.



Shown at the left is the new A. W. Haydon Co. catalog describing the complete line of timing motors and devices; if you haven't received your copy write for it on your company letterhead.

A.W. HAYDON Company

227 NORTH ELA STREET, WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 364 ON READER-SERVICE CARD

Semiconductor Wave Generator

Patent No. 2,801,340 Edward Keonjian and Jerome J. Suran. (Assigned to General Electric Company)

The generator uses a semiconductor having at least two spaced ohmic electrodes and a rectifying junction associated with the electrodes in a region affected by a potential applied between the ohmic electrodes. A first resistance connects a suitable potential to the rectifying junction. Between the rectifying junction of the semiconductor and the low potential ohmic electrode is a series circuit including a unilateral conducting device and a parallel circuit of a second resistor and capacitor.

Multivibrator Circuit

Patent No. 2,802,940. Everett T. Burton. (Assigned to Bell Telephone Laboratories, Inc.)

The multivibrator uses a pair of tubes having their electrodes interconnected so as to form a monostable multivibrator circuit having two stable states. A timing capacitor is provided between the grid of the

first of the pair of tubes and the plate of the other tube. A source of synchronizing pulses is switched to the grid of this first tube for applying an initiating pulse which renders this tube non-conducting upon the occurrence of the synchronizing pulses. The switch means is inhibited when this first tube is non-conducting and for a predetermined period after the tube becomes conducting by a feedback path from the plate of the first tube to the switch means.

Diode Detector-Transistor Amplifier

Patent No. 2,802,938. Gerald B. Herzog. (Assigned to Radio Corporation of America)

The amplifier uses a transistor having the usual electrodes which are biased from a source of potential. A diode rectifier is in series with the base electrode to provide signal detection for a receiver. The base-emitter circuit of the transistor provides the sole output current path for the diode rectifier which is poled for forward conduction in the same direction as the base current of the transistor.



HOLD
and
COOL
transistors
with



BIRTCHER TRANSISTOR CLIPS

MATERIAL

Beryllium #25

FINISH

Choice of Cadmium,
black Ebanol or
Silver plated

SIZES

Available in sizes and
modifications to
retain all popularly
used transistors.

Birtcher TRANSISTOR CLIPS perform the dual functions of retention and heat reduction. Being made of tempered beryllium copper they grip the transistor securely and hold it in place even under severe conditions of shock and vibration. In addition they provide an excellent heat path to drain off heat into chassis or heat sink.

Write for catalog

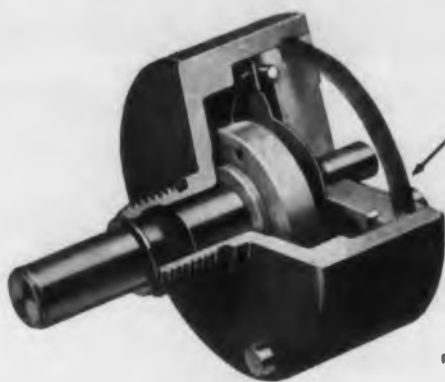
THE BIRTCHER CORPORATION

INDUSTRIAL
DIVISION

4371 Valley Blvd.,
Los Angeles 32, Calif.

CIRCLE 365 ON READER-SERVICE CARD

*we don't make
a "SPECIAL"
of sealing out
SMOG,
SMOKE
and SWEAT*



"O" rings lock out dust and moisture.

PRM-123
Precision
Potentiometer
Rotary type,
linear, single
turn, 1 1/4" dia.,
bushing
mounted, sleeve
bearing.

This particular little precision pot of ours meets Government specs, competitive specs and specs that haven't been written yet, but we feel none of that lifetime performance is worth anything to you unless it's *sealed in*—against smog, smoke and sweat for the life of the pot. So we seal all our pots as *standard*, and don't charge you extra, to safeguard the dependability we've built *into* the pot.

General Controls maintains forty-two factory branch offices in key cities, staffed with sales engineers who know the story on why this PRM-123 is a better pot for you. They are in the phone book. Give them a call.



GENERAL CONTROLS ELECTRONICS DIVISION

Glendale, California • Skokie, Illinois • Guelph, Ontario, Canada
Factory Branch Offices in 42 principal cities

CIRCLE 366 ON READER-SERVICE CARD

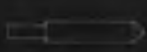
NOW in **ONE** temperature transducer.

FOR TELEMETERING AND CONTROL.

$$\Delta R \approx 50 \Omega / ^\circ F.$$

—320°F ————— WIDE RANGE ————— +550°F
RESISTANCE INCREASES OVER 40,000 ohms.

- continuous output 0 to 5 volts in bridge circuit without amplification or power commutation.
- models with pressure rating up to 12,000 psi.
- for use in highly corrosive gases and fluids.
- meets MIL-E-5272A.
- special transducers to +2,200°F.



BEARINGS



FLUIDS



GASES



SURFACES

**FAST DELIVERY . . . standard items in stock
REPRESENTATIVES IN PRINCIPAL CITIES**

Write for information on TELETEMP — a complete, miniature system for telemetering temperatures; and TEMPRO — a measuring and warning system for aircraft and industry.

**CARDINAL INSTRUMENTATION CORPORATION
A-1 4201 Redwood Ave., Los Angeles 66, Calif.**



CIRCLE 367 ON READER-SERVICE CARD

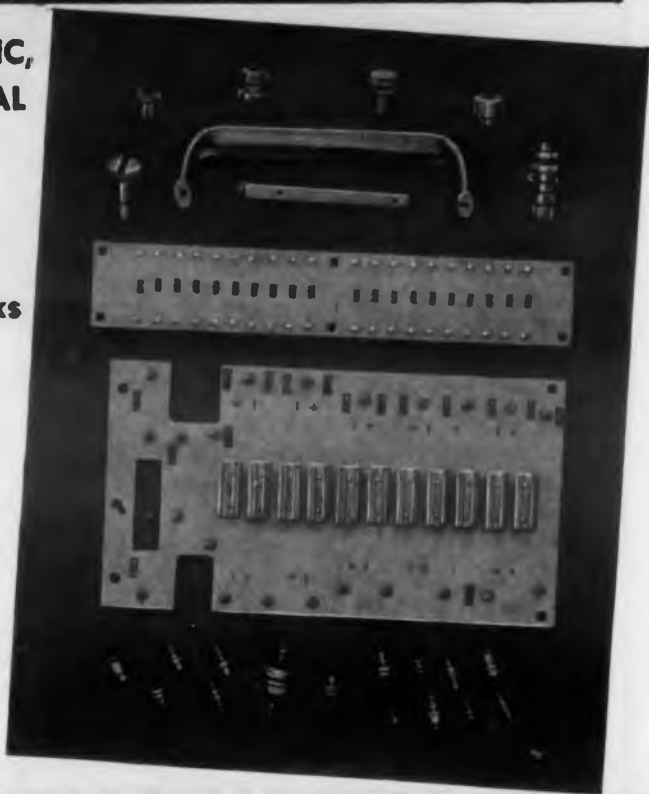
ELECTRONIC HARDWARE

PARTS for ELECTRONIC,
ELECTRO-MECHANICAL
and AIRCRAFT-
STANDARD or to
SPECIFICATION

- Dial and Shaft Locks
- Standard Terminal Lugs
- Terminal Boards
- Handles

*Immediate delivery
from stock or to
order on all items.*

Write for catalog E



GCI

GENERAL COMPONENTS, INC.
225 EAST 144th STREET, NEW YORK 51, N. Y.
Telephone: MO 5-0740

CIRCLE 368 ON READER-SERVICE CARD



with
IFI AMPLIFIERS

In combination, IFI amplifiers deliver a Cascade of Power — a gain as high as 46 DB! With bandpass 200KC-220MC wide, you get power output of 3 watts. And you can measure pulses with rise time as short as 3 millimicroseconds!

DO YOU NEED AN OUTPUT OF 25 VOLTS BUT HAVE A SIGNAL SOURCE THAT FURNISHES ONLY 120 MILLIVOLTS? . . . A cascade of IFI amplifiers is your answer. A Model 530 driving a Model 510, in turn connected to a Model 500 and fed with a signal of 120 millivolts (peak), will furnish an amplitude of 25 volts peak. And the input pulse may be positive or negative with a rise time of 2 or 3 millimicroseconds.

By using other combinations of IFI amplifiers even larger gain and output can be achieved. Study these specifications:

	530	510	500
Bandpass	10 kc to 300 mc	200 kc to 220 mc	200 kc to 220 mc
Gain	voltage—18 db	16 db	Power—12 db
Input Impedance	135 ohms	90 ohms	90 ohms
Output Impedance	150 ohms	185 ohms	185 ohms
Power Output	.08W Max.	0.75 watts	3 watts
Output Voltage	3.5 V. rms, Max.		22 V. rms, 62 V.
Rise Time	Less than 2×10^{-7} sec.		.0025 microseconds
	\$245.00	\$325.00	\$330.00

We, too, need
engineers. Contact
John V. Hicks,
Pioneer 2-5300

Price, F.O.B. Mineola, New York (Subject to change without notice)



INSTRUMENTS FOR INDUSTRY, Inc.

159 GLEN COVE RD. MINEOLA, N. Y.

PHONE: PIONEER 2-5300

CIRCLE 369 ON READER-SERVICE CARD

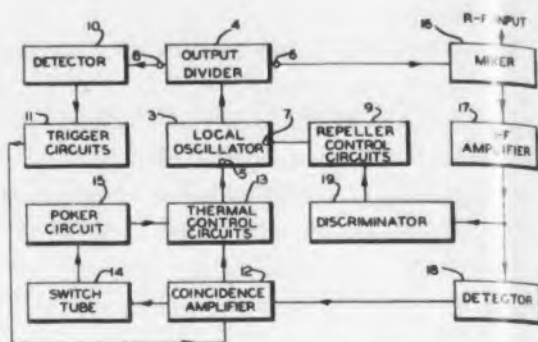
Patents

Automatic Frequency Control System

Patent No. 2,789,226, G. H. Nibbe. (Assigned to the United States of America)

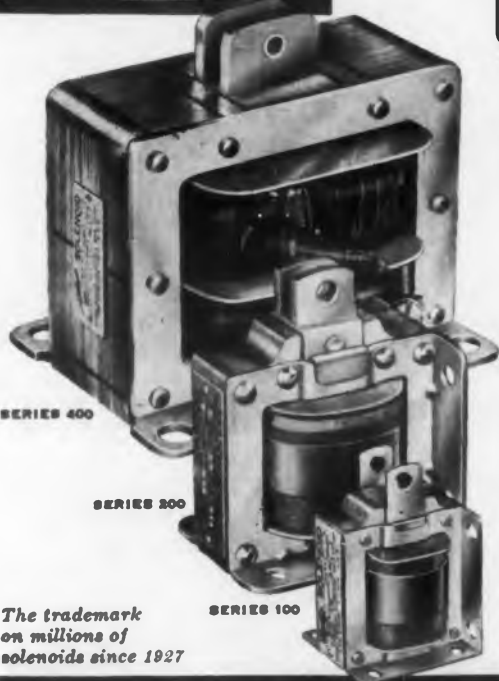
The circuit illustrated provides a control system which is used for automatically tuning an oscillator. These systems are commonly used to control a local oscillator. The available systems presently used lack sufficient range and rapidity of response to a change in frequency and the circuit described improves these characteristics.

The oscillator 3 uses a tube having both mechanical and electrical control such as a Neher tube in which the mechanical control 5 is the thermal and the electrical is a repeller circuit 7. The output of the oscillator is divided at 4 with part of the signal going to the mixer 16 to produce an i-f signal from the rf input. The i-f signal is amplified and fed to a discriminator 19 which generates a positive signal in the event that the frequency changes in one direction from the fixed i-f and generates a negative signal for a frequency change in the



other direction. The signal from the discriminator controls the repeller control circuit 9 which maintains the oscillator 3 on frequency.

Another part of the output of the oscillator 3 goes to a detector 10 which produces a dc voltage proportional to the oscillator output and applies the potential to a trigger circuit 11 having two conditions of stability. If the output is above the desired value, the trigger circuit is activated to one condition of stability and vice versa. The output of the trigger circuit is differentiated to provide a positive or negative trigger



The trademark on millions of solenoids since 1927

WesCo has the AC solenoids you need... in the quantity you need!

WesCo's famous Series 100, 200 and 400 AC solenoids—75 models in all—are immediately available in small or large quantities! One of these designs may fit your requirements. If not, WesCo engineers will design a special solenoid for your application. Inquire now.

WesCo designs and manufactures aircraft solenoids for military and commercial application. Write for complete catalog.



WEST COAST ELECTRICAL MFG. CORP.

233 W. 116TH PLACE • DIVISION 110 • LOS ANGELES 61, CALIFORNIA • PLYMOUTH 5-1138

CIRCLE 370 ON READER-SERVICE CARD

pulse when the output of the oscillator drops below or approaches its maximum. The pulse is one of two signals which controls a coincidence amplifier 12. This component may be a pentode with its suppressor grid biased below cut off and triggered by the pulse to conducting potential. The control grid is controlled by a dc signal received from a detector 18 in the i-f circuit as long as the frequency of the oscillator 3 is near enough to the proper frequency to produce an i-f signal. A signal from the amplifier 12 controls the thermal circuit 13.

Should the oscillator be far off from the desired frequency so that the control elements described are ineffective, the "poker" circuit 15 comes into operation. This is a low frequency control oscillator which gives the thermal control circuits sufficient time to tune the oscillator 3 through its entire range. When oscillator 3 is on or adjacent to frequency, the output of coincidence amplifier 12 is sufficient to keep the detector or switch tube 14 operative to maintain the control oscillator 15 normally inoperative. It becomes operative when the signal from the coincidence amplifier is insufficient to keep the tube operative.

Stabilized Feedback Amplifier

Patent No. 2,802,070 Harold L. Fishbine and Curtis Sewell, Jr. (Assigned to United States Atomic Energy Commission)

In a simple form of the amplifier, a first and a second vacuum tube are used with the signal input applied to the control grid of the first tube. An anode load impedance has an end connected to the anode of the first tube. The control grid of the second tube is coupled to the anode of the first tube. A parallel resistance-capacitance network is provided between the cathode of the first tube and the anode of the second tube. A series resistance-capacitance network of substantially lower impedance than the impedance of the parallel network is provided between the cathode of the first tube and the cathode of the second tube. A potential source supplies anode potential for the first tube through the anode load impedance and has its negative terminal applied to the cathode of the second tube. The amplifier in its more desirable form uses a screen grid tube for the second tube and a decoupling network between the junction of the resistor and capacitor of the series resistance-capacitance network and the screen grid.



PHILLIPS SUB-MINIATURE RELAYS

Phillips relays are advanced-design sub-miniatures produced with the meticulous care required for service under severe conditions. Combining dependability, compactness, lightness and ruggedness. Proven by years of application. Write for literature on these and other relays, available in a permanent, three ring binder.

Phillips Control Corporation, Joliet, Illinois — AN ALLIED PAPER CORPORATION
SUBSIDIARY — SALES OFFICES: NEW YORK - PHILADELPHIA - BOSTON - SAN FRANCISCO - DENVER - SANTA MONICA - WASHINGTON - WINSTON SALEM - CLEVELAND - DALLAS - SEATTLE - KANSAS CITY - ST. LOUIS - DETROIT
CIRCLE 371 ON READER-SERVICE CARD

*High stability
French
products*

For
U.S.A.
industry

CAPACITOR KNOBS

- Uncoupling Knobs Types : CB 11 N and CB 11 P
NORM MIL B 10 950 A



C	$\frac{\Delta C}{C \Delta \theta}$	Stability
$12 \leq C \leq 1000$	$0 \leq \frac{\Delta C}{C \Delta \theta} \leq 70.10^{-4}$	$\pm (3.10 \pm 0.1 \text{ pf})$

- Mica Capacitors "STABILIDISC"



C	$\frac{\Delta C}{C \Delta \theta}$	Stability
$12 \leq C \leq 1000$	$1.5 \times 10^{-4} \leq \frac{\Delta C}{C \Delta \theta} \leq 45.10^{-4}$	(high stability) $\pm (3.10 \pm 0.1 \text{ pf})$

The high performance of the capacitors results from being hand-made

The same high performance is guaranteed in the large series

Write for samples :

TRY THEM AND VERIFY THE QUALITY ... AND THE PRICE

STÉAFIX

17, rue Francœur, PARIS 18^e (France)
Tél. : MONTmartre 61-19 et 02-93

Use a
good condenser
and
you won't waste
your money
on repairs

SOFEL PARIS

CIRCLE 372 ON READER-SERVICE CARD



KAY

Microwave Mega-Nodes

CALIBRATED NOISE SOURCES
AT MICROWAVE FREQUENCIES

Designed for the measurement of noise figure, receiver gain, and to calibrate standard signal sources in radar and other systems, the Kay *Microwave Mega-Nodes* are available with either argon or fluorescent tubes. Argon tubes cover the ranges from 1200 to 1400 mc and 2600 to 26,000 mc; fluorescent tubes from 1120 to 12,400 mc.

SPECIFICATIONS

Noise Output, all sizes: Fluorescent, 15.8 db \pm 0.25 db; argon, 15.28 db \pm 0.1 db.

Temperature Correction Factor: Fluorescent—0.05 db per degree C above 32° C. Argon—none.

Power Supply: Input approx. 65 watts, 117 V (\pm 10%), 50-60 cps ac.

PRICES*

Universal Power Supply . . . \$100.
RG-69/U . \$400. | RG-50/U . \$195.
RG-48/U . 195. | RG-51/U . 195.
RG-49/U . 195. | RG-52/U . 195.

*One power supply with any 3 \$195. waveguide types—\$600. Additional waveguide types in \$195. bracket—\$167. ea.

For New Kay Catalog, Write:

KAY ELECTRIC COMPANY

Dept. ED-11

Maple Avenue, Pine Brook, N. J.

CAldwell 6-4000

CIRCLE 373 ON READER-SERVICE CARD

In looking for faster, lower-cost production methods, for you or your customers, do not overlook one of the easiest, least expensive and most effective ways:



Type MA FOOT SWITCH

Light-weight, fast-operating Foot Switch. Ease of operation assures minimum fatigue. SPDT internal switch is long-life General Control "du.op" Limit Switch. Modern design; attractively finished in grey and red.

Removable end. Access to internal terminals by simply unscrewing front end.

FOOTROL
GENERAL CONTROL
foot switches — the recognized leaders — for dependable, fast, efficient control. Select from a complete line of foot switches with standard and heavy-duty ratings.

Write for Bulletin FS-200

General Control
customer-approved
Foot Switches



MA



MC



MI

FOOT LEVER, PUSH BUTTON and LIMIT SWITCHES
ELECTRONIC and SYNCHRONOUS-MOTOR TIMERS
CUSTOM CONTROL PANELS

GENERAL CONTROL COMPANY

1207 Soldiers Field Road • • Boston 24, Massachusetts

CIRCLE 374 ON READER-SERVICE CARD

BLILEY CRYSTALS-BLILEY OVENS Combine for Greater Stability.....

NEW BLILEY BULLETIN

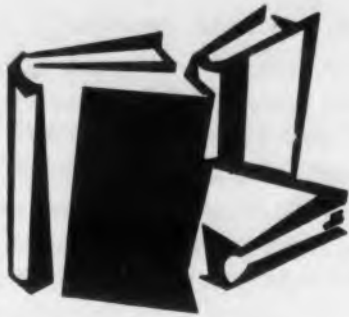
Bliley

The inherent frequency stability of Bliley crystals is greatly enhanced by temperature control. Bliley builds various types of crystal ovens for this purpose. A new bulletin showing the combined performance of Bliley crystals and ovens is available.

REQUEST BLILEY BULLETIN #507.

BLILEY ELECTRIC COMPANY
UNION STATION BLDG. • ERIE, PA.

CIRCLE 375 ON READER-SERVICE CARD



Books

Basic Automatic Control Theory

Gordon J. Murphy, D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, N.J. 557 pages, \$10.75

This volume presents the most modern concepts of automatic control theory. The author thoroughly describes the analysis and synthesis of linear control systems having fixed, lumped parameters and subject to specifiable input commands and disturbances. He illustrates theory by extensive use of practical examples from several fields, including process control, inertial guidance and fire control.

After defining terms and outlining the applications of practical systems, the book discusses physical analogies and the characteristics of common control-system components. A rigorous treatment of the

Laplace transform is followed by a presentation of the generalized transfer-function concept and signal-flow diagrams. The author next defines system types, detailing the extension of the transfer-function concept to carrier systems. Stability and the frequency-response techniques of analysis and synthesis are explained with the help of numerous illustrations.

The time response of control systems is discussed at length, using root loci to allow swift determination of the system's behavior. The author then correlates the frequency-response and time-response methods, showing the advantages and disadvantages of each. The final chapter covers analog computers and their applications, using systems discussed in earlier chapters of the book.

this new
BREVEL
gear-head
motor

PROVIDES LOW-COST
SLOW MOTION



This gear-head motor, like all Brevel motors, is volume produced . . . to your exact specifications—or you can order from a wide stock selection. Modifications are easily made to meet desired speed, rotation, shaft length, and type of application (continuous or intermittent).

Write, wire or phone today, for informative bulletin NSW-28. Better still, outline your problem or send us your specifications—

BREVEL PRODUCTS CORP., 601 W. 26th St., New York 1 • WA-4-4737

SLOW MOTION IS OUR BUSINESS!

CIRCLE 376 ON READER-SERVICE CARD

BREVEL

Principles of Mass and Flow Production

Frank G. Woollard, *Philosophical Library, 15 East Fortieth Street, New York 16, N.Y. 195 Pages, \$7.50.*

After defining the terms mass production and flow production, the author briefly traces the history of this type of manufacture. He lays down a series of eighteen basic principles that relate to the set up of a flow production plant, and considers the implication of each in detail. Flow production is frequently thought of as being suitable only for large and highly organized enterprises. The author stresses that its methods can be applied with the same benefits to small quantities in small firms, and that large capital is not essential to their introduction. The methods and principles described are suitable for the manufacture of almost every article that is readily and continuously saleable. Production executives in a wide range of industries as well as students of engineering economics will find

The book also covers some of the problems arising from automation, and there is a chapter developed to the automatic factory of the future. The text is amplified by photographs and diagrams of significant production examples from the United States, Britain, and Europe.

Transistor A. F. Amplifiers

D. D. Jones and R. A. Hilbourne, *Philosophical Library, 15 E. 40th St., New York 16, N.Y. 152 pages, \$6.00.*

This book deals systematically with the design of transistor audio frequency amplifiers. It gives the circuitry and design details of a versatile range of amplifiers.

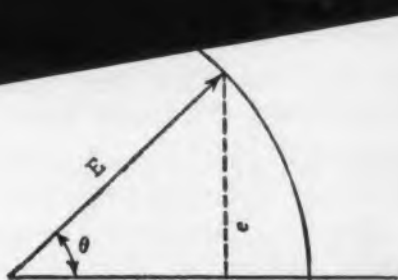
Until recently, it was not possible to design high-powered transistor amplifiers free from distortion. This difficulty has been overcome by the many improvements in the thermal and electrical characteristics of these devices.

After discussing the electrical characteristics of transistors, the authors explain a method of overcoming the main problems in the design of input stages with high signal to noise ratio, and output stages with maximum efficiency and minimum distortion. Methods of applying negative feedback and of manually controlling the gain and frequency distortion are also discussed.

Design details of five circuits with proven performance, with outputs ranging from one to twenty watts are given to show the practical application of the theories.

Other chapters cover power supplies complementary symmetry and transistor amplifier applications.

new from trio...



build-in miniature phase-sensitive AC VTVMs

for building into military & industrial test & operating equipment. Both single- and multi-range zero center models indicate $V \cos \theta$ — the product of signal magnitude & cosine of phase angle between signal & reference voltages. No controls or operating adjustments. When signal & reference are in phase, meter deflects to right; when out of phase, to left. Ideal for AC null readings. Perfect quadrature rejector as long as signal magnitude does not exceed full scale. Wide variety of standard packages. Sensitivities of single-range models from 10 MV; multi-range, as low as 1 MV.

For free 36 page Engineering Guide, write to Dept. **40-11**

Trio Laboratories., Seaford, N. Y.

when ordinary instruments are too big or inadequate...

trio

CIRCLE 377 ON READER-SERVICE CARD

announcing

A NEW CAMLOC

ELECTRONIC

CHASSIS LATCH

for easier handling of heavy equipment



- Larger—for easier carrying
- Lighter—to save weight
- Cam operated safety guard against accidental release
- Simplified mounting
- One motion release—lock operation
- Interchangeability permits use of two types of fork assemblies



Camloc's newly-designed Model 27L Electronic Chassis Latch incorporates all the proven features of the 21L which has found wide acceptance since its introduction two years ago...yet offers the added advantages of larger handle size for greater ease in carrying heavy equipment (up to 600 pounds, ultimate load) and is 30% lighter! The 27L also provides cam action for engaging and disengaging multiple contact plugs. Handles are interchangeable with smaller Model 21L, creating a selection of fork assemblies to meet varied requirements. Handle and fork comprise a working unit.

Uses for Camloc Electronic Chassis Latches include airborne radio racks; various electronic equipment; automatic pin spotters; aircraft ground handling equipment; food process machinery.

Complete information is available on request. Ask for Bulletin No. 27L.

"Specialists
in fasteners
for Industry"

CAMLOC

FASTENER CORPORATION
61 Spring Valley Road, Paramus, N. J.

CIRCLE 379 ON READER-SERVICE CARD

What the Russians are Writing

J. George Adashko

AUTOMATION AND TELEMECHANICS

(Contents of *Avtomatika i Telemekhanika* No. 4, 1957)

SERVOMECHANISMS

Use of Memory Device to Improve the Stabilization of Automatic Regulation Systems with a Servo Drive of Limited Speed, V. A. Kotel'nikov, (15 pp, 15 figs.).

An automatic-regulation system with an operating mechanism of limited speed pulling in from an arbitrary initial position can be stabilized by using a memory and switching device in conjunction with a proportional feedback regulator. (A similar device was described by Maslennikov in the February, 1956 issue of *Avtomatika i Telemekhanika*, ED August 1, 1956). The stability limits of such a system are determined and used to obtain the permissible regulator parameters. The increased stability makes it possible to increase the gain of the system by a factor of three and to increase the amplitude of the control system almost without limit regardless of the presence of a time-delay in the regulator. This in turn makes it possible to choose the maximum speed of the operating mechanism without worrying about stability.

Analytical Investigation of Stability of an Electromechanical Transducer, I. M. Makarov, (9 pp, 6 figs.).

Automatic-regulation systems are frequently simulated by connecting the analog of the regulation object to the actual regulator through a special transducer converting some electrical quantity into a corresponding mechanical one. This article treats a device (Fig. 1) to convert dc voltage into an angle; the equations of motion are derived and the stability problem is solved.

The electrodynamic clutch was discussed in detail in the October, 1956 issue of *Avtomatika i Telemekhanika* (ED, June 15, 1957).

Certain Problems in the Design of Multi-Channel Automatic Regulation Systems, V. P. Kazakov, (12 pp, 14 figs.).

The use of multi-channel (multiple-point) equipment reduces the bulk of the apparatus required to automatize objects with a large number of controllable variables. The article is devoted to the design of time-sharing multi-channel automatic regulation systems with contactless elements. Reference is made to "Magnetic Switching Network for Data Handling Systems," by L. P. Gieseler (*Proceedings of the National Electronics Conference*, Volume 10, 1953) and to "Accurate Linear Bi-Directional Diode Gates" by Millman and Puckett (*Proc. IRE*, Volume 43, November, 1955).

INFORMATION THEORY

Information-Theory Criteria for the Evaluation of Telemetering Systems, M. M. Bakhmet'ev, R. R. Vasil'ev (5 pp, 1 fig.).

Information theory can be applied to telemetering more successfully than to, say, telephony or television where the transmission loop contains human information-handling "devices" and the criteria must of necessity involve a certain arbitrariness. The parameters of the information channel used in telemetering are more accurately known (noise is the only exception). Criteria are developed for several standard telemetering systems.

Analysis of Errors in the Determination of the Mean Value of a Random Quantity and its Square, Resulting from the Finite Observation Time, A. E. Kharybin, (11 pp, 3 figs., 2 tables).

The determination of the mean value of a random quantity and of its dispersion, observed over a finite time, is subject to errors. Equations are derived and used to plot nomograms from which one can estimate in turn whether the statistical observation interval is large enough.

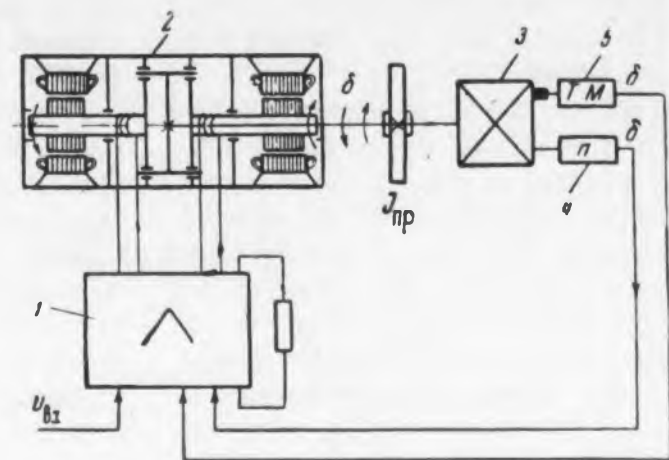


Fig. 1. The basic elements of the converter are the control amplifier 1, the actuating mechanism (electrodynamic clutch) 2, reduction gear 3, proportional feedback potentiometer 4, and derivative-feedback tachometer generator 5.

ANALOG COMPUTERS

Analog Multiplier and Divider Using Thyrite Resistors, A. A. Maslov (13 pp, 14 figs.).

The author describes a new multiplication circuit using thyrite squaring elements and requiring only two operational amplifiers. A new analytic method is also devised for determining the parameters of the thyrite elements. Refers to "An Analogue Multiplier Using Thyrite" by Kovach & Comley (*IRE Transactions—Electronic Computers*, June, 1954).

MAGNETIC AMPLIFIERS

Half-Wave Magnetic Amplifiers, Part I, H. A. Lipman, I. B. Negnevitski, (22 pp, 14 figs.).

The fast-response half-wave magnetic amplifier was first proposed by Ramey in 1951 (*On the Mechanics of Magnetic Amplifier Operation, Transactions AIEE*, Volume 70, Part II, 1951). The article contains a more detailed analysis of the Ramey circuit than found heretofore in the literature, and derives a set of general equations and curves from which it is possible to obtain the characteristics of any specific amplifier. The generalized characteristics are calculated only once, and need not be repeated again. The calculated and experimental data are found to be in good agreement if good magnetic material with a rectangular hysteresis loop is used.

ELECTRICAL COMMUNICATIONS

(Contents of *Elektrosvyaz* No. 4, 1957)

TELEVISION

Effect of Periodic Noise on the Quality of a Television Image, A. P. Efimov, (7 pp, 5 figs.).

Description of experimental setup, the procedure used in the experiments, and an investigation of the effect of periodic noise (at a frequency above 0.1 mc) on the quality of a television image.

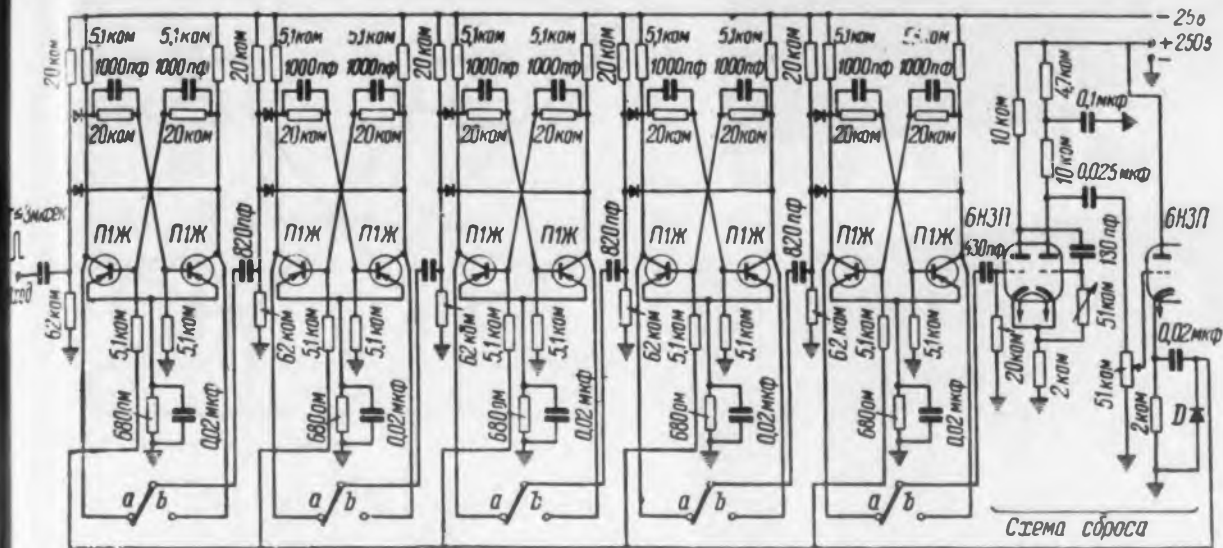


Fig. 1. Principal diagram of a complete frequency divider for a range from 1 to 32 (2^5), operating at a temperature range from -60°C to 70°C , and a voltage fluctuation of $\pm 20\%$. The frequency of the trigger impulses can be as high as 50 kc. (Note—Resistances are in kilohms, capacitances in micro-farads.)

The author concludes that periodic unmodulated noise produces a visible noise pattern on the screen if the frequency is less than approximately 3 mc; noise of higher frequency changes the brightness and contrast of the image. Periodic unmodulated noise is more noticeable than unmodulated noise, particularly below 3 mc, and the signal to noise ratio in the television channel depends considerably on the noise frequency. Refers to "Effect of Noise and Interference on Television Transmission," Jarvis and Seaman, *Post Office Electric Engineering Journal*, Vol. 2, Part III, 1939) and to "Local Oscillator Radiation and Their Effect on Television Picture Contrast," E. W. Herold, (*RCA Review*, Vol. 7, No. 1, 1946).

Investigation of Aperture Distortion by the Method of Doubling the Reproduced Images, Ye. L. Orlovski, (12 pp, 9 figs.).

Aperture distortion in a channel of limited bandwidth is shown to produce blurring in the reproduction of black and fine image details, similar to what is produced by superimposing two images that are shifted relative to each other by a certain distance. Curves are given for the dependence of the loss of optical density in the reproduction of single and double lines on the bandwidth of the communication channel and dimensions of the aperture. Refers to "Television Resolution as a Function of Line Structures," by H. Carwein (*Proc. IRE*, Vol. 33, No. 12, 1945).

TRANSISTOR CIRCUITS

Binary Junction-Transistor Frequency Dividers, A. R. Luninski, N. M. Trakhtenberg, (7 pp, 6 figs., 1 table).

Mostly because of temperature limitations, modern transistors are difficult to use in frequency-divider circuits. This difficulty is overcome to a considerable extent in a binary divider (Fig. 1) consisting of a series of trigger cells

* a-c stands for analog computer



The Donner a-c, a complete linear computer. Digital voltmeters, scopes, and non-linear equipment may be mounted above the console and/or at one side in modular racks.*

\$16,650

buys the new **DONNER** a-c* console

WITH

- 30 Chopper Stabilized Amplifiers
 - 40 Coefficient Potentiometers
- 0.1% Temperature Controlled Computing Components
 - Latching Overload Lights

* Designed as a standard production item, the Donner a-c* combines quality and flexibility with modest cost. For instance, characteristics of the Donner 3101 chopper stabilized operational amplifier, heart of any analog computer, are: dc gain 5×10^7 ; unity integrator drift 100 millivolts in 15 minutes; phase shift 0.2° at 1000 cps. The reference supply carries a stability of $\pm 0.1\%$ over a 60 day interval.

Formed from molded diallyl phthalate, the removable AMP problem board serves 30 amplifiers, 40 potentiometers, complementary nonlinear equipment, and 70 trunk lines.

Starting with as few as 10 amplifiers and 20 potentiometers, the user can build up a full console as his needs and pocket-book dictate. For further expansion, consoles may be slaved together and operated from one master computer.

Data file 310 detailing the Donner a-c* is yours for the asking. Please address Dept. 1911

DONNER SCIENTIFIC COMPANY

Phone MUIberry 2-6161 • Cable "Donner"
CONCORD, CALIFORNIA

CIRCLE 380 ON READER-SERVICE CARD

Everybody profits
...because
you
belong
in this
picture!



The publisher of this magazine is often asked what kind of a man you are . . . and how many like you are receiving his magazine. Why is he asked?

Because the advertisers (whose money is his chief income) insist upon knowing the types of people (by industry or profession, by title) for whom the magazine is edited — and how many are getting it.

In order to standardize on the presentation of such information to advertisers and to have its accuracy vouched for by a disinterested third party, nearly 450 publishers have joined some 200 leading advertisers and advertising agencies in a non-profit organization called Business Publications Audit.

The purpose of BPA is to assure advertisers . . . by frequently checking and rechecking . . . that each member publisher is indeed distributing his magazine, in the numbers promised, to the types of men he promised would receive it.

The BPA symbol in this magazine means that you belong . . . that because of your occupational interests you are qualified, in the eyes of the advertisers, to receive it.

The advertiser can thus tell whether he's getting his money's worth.

The publisher has a better sales story to prospective advertisers because his magazine is "audited."

And you, the reader, get more value from the magazine because both the advertisers and editors, knowing what your special occupation is and what your interests are, are better able to prepare advertising and editorial material that will be most informative and useful to you.

What you can do

Publishers and advertisers frequently write to magazine readers to learn what kind of articles and advertisements appeal most. Cooperate with them — will you? — by answering their questions . . . in the interest of better communications between makers and markets.

**BUSINESS PUBLICATIONS
AUDIT OF CIRCULATION, INC.**

420 Lexington Avenue New York 17, N. Y.

BPA

A NON-PROFIT, TRIPARTITE MEMBERSHIP CORPORATION OF ADVERTISERS, ADVERTISING AGENCIES AND BUSINESS PUBLICATIONS

Published as an industry service by Hayden Publishing Company Inc., member of BPA.

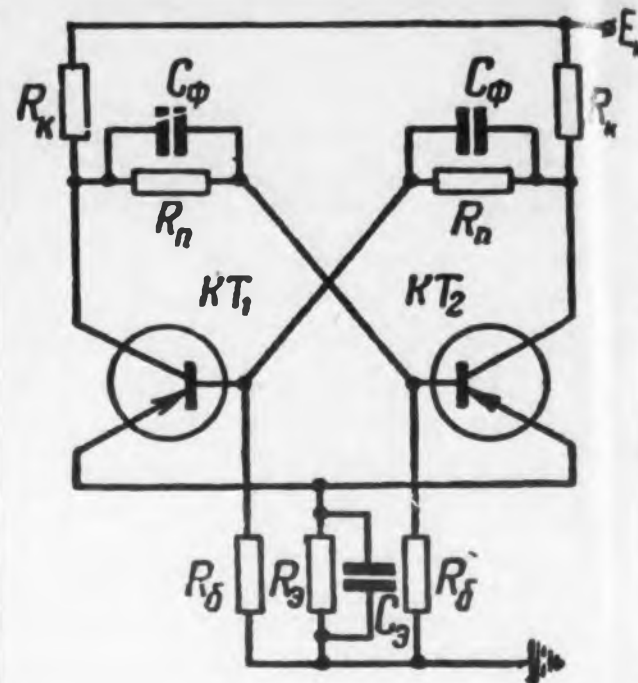


Fig. 2. Standard transistor trigger circuit.

(Fig. 2) employing P1E and P1Zh junction transistors. It is shown that proper selection of the circuit and the operation conditions of the trigger results in reliable operation of the frequency divider over a wide range of frequency ambient temperature and line voltage.

Reference is made to "Junction Transistor Multi-Vibrators and Flip-Flops" by E. Sard (*Convention Record of the IRE, Part II, 1954*, "A Variable Binary Scalar" by D. Murray (*IRE Transactions Electronic Computers, June, 1955*).

INFORMATION THEORY

On the Possibility of Compressing the Spectrum of a Signal, A. A. Kharkevich, (9 pp, 7 figs.).

Contains a general discussion and certain examples of non-statistical and statistical spectrum compression.

THERMIONICS

Thermal Grid Emission in Metal-Ceramic Tubes, E. P. Korchagina, G. M. Utkin, (10 pp, 15 figs.).

Experimental data on the energy relationships in the anode and grid circuits of a metal-ceramic tube under the influence of thermal grid emission, which occurs at high excitation, and which reduces considerably the useful life and the efficiency of the oscillator. It is shown that automatic bias in the cathode and grid circuits causes higher thermal emission.

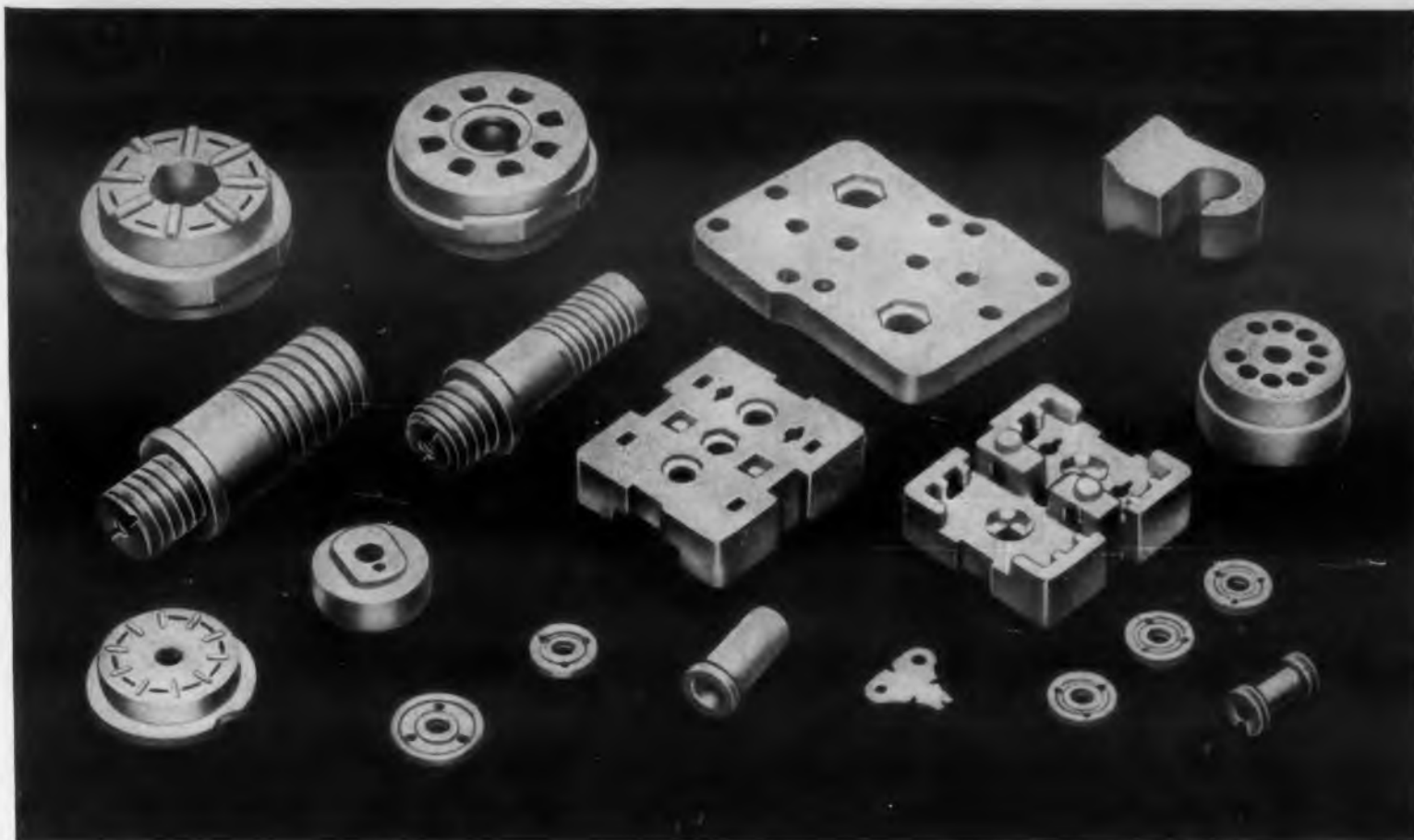
RECEIVER DESIGN

Selection of Interstage Coupling Network for FM Receivers, L. Ia. Kantor, (4 pp, 1 fig., 3 tables).

Interstage coupling circuits consisting of single tuned circuits and of band filters are compared.

No. 1 solution to dielectric problems—

PRECISION STEATITE by GENERAL CERAMICS



G-C steatite solves all of these problems...economically

- ▶ Widely varying ambient temperature
- ▶ Severe mechanical or thermal shock
- ▶ Permanence of dimensional accuracy
- ▶ Intricate shapes to close tolerance
- ▶ Efficient compaction of physical size
- ▶ Low electrical loss at high frequency
- ▶ High dielectric and mechanical strength
- ▶ Extreme immunity to environmental conditions

G-C electrical ceramics are news! Offering a far higher degree of dimensional accuracy than ever before possible, precision dielectrics provide a far greater design latitude in all types of electronic and electrical equipment. These new high accuracy ceramics are another example of

General Ceramics progressive manufacture . . . better products at lower cost through advanced research and improved methods of production. Why not ask for all the facts on precision electrical ceramics, now! Write General Ceramics Corporation, Keasbey, New Jersey, Dept ED.

GENERAL CERAMICS

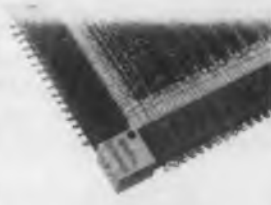
Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES



FERRAMIC MAGNETIC CORES



MAGNETIC MEMORY PLANES



"ADVAC" HIGH TEMPERATURE SEALS



SOLDERSEAL TERMINALS

CIRCLE 382 ON READER-SERVICE CARD

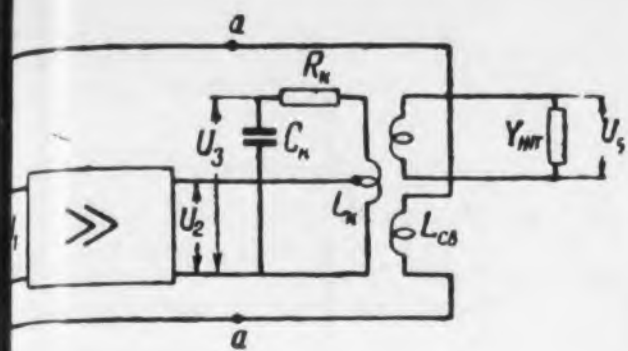


Fig. 1. Equivalent circuit for transistor oscillator (Y_{nr} — load, L_x — feedback coil, L_k , R_k , C_k — collector parameters).

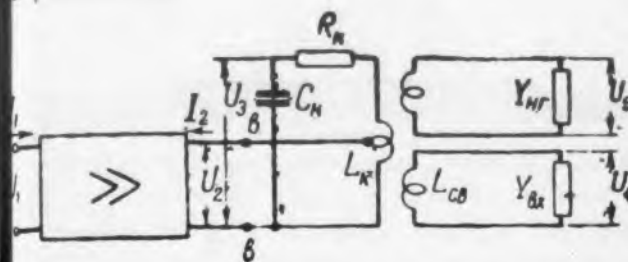


Fig. 2. The voltage gain of this circuit yields the simplified oscillator equations. (Y_{bx} — input admittance)

from the point of view of their application to fm receivers. Band filters are shown to be preferable in low-sensitivity receivers while single-tuned circuits are best for high sensitivity. An equation is derived for the selectivity of a receiver employing a single tuned circuit with frequency feedback.

Other Articles in This Issue

On Noise Rejection in Various Methods of Radio Telegraphy, Iu. S. Lezin, (8 pp, 4 figs.).

Principles of Design of Apparatus for Simplified Systems of Multi-Channel Communication over Cable and Radio-Relay Lines, K. P. Egorov, M. U. Poljak, (7 pp, 5 figs.).

Protection of Reinforced-Concrete Communication-Line Poles Against Direct Lightning Strokes, M. I. Mikhailov, S. A. Sokolov, (8 pp, 6 figs., 4 tables).

RADIO ENGINEERING

(Contents of Radiotekhnika No. 4, 1957)

TRANSISTOR OSCILLATORS

Simplified Analysis of High-Frequency Self-Excited Transistor Oscillator Circuits, P. D. Berestnev, (6 pp, 3 figs., 1 table).

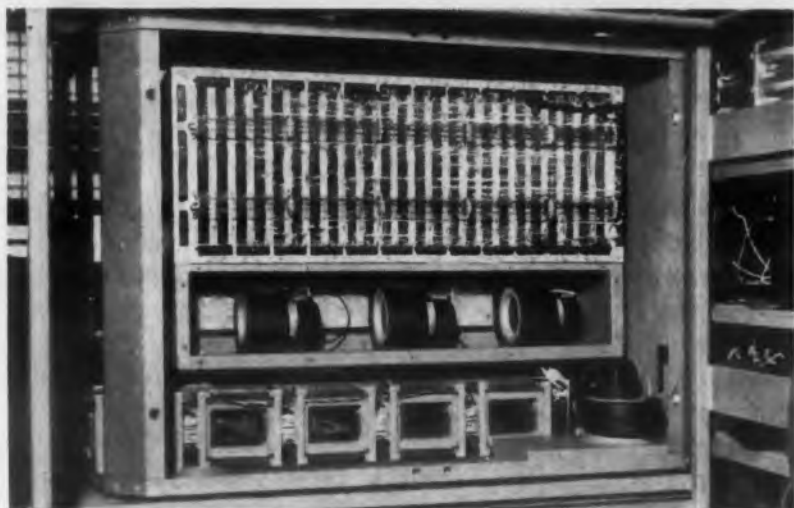
Fig. 1 shows the transistor oscillator represented as a four-terminal network, and Fig. 2 shows the same circuit with the feedback loop open (at "aa") and the feedback coil loaded by the input admittance of the circuit. The expression for the voltage gain of this circuit, used in conjunction with the Nyquist criterion, leads to simplified expressions for the frequency and for the self-excitation conditions of a grounded-emitter or grounded-base oscillator with the resonant circuit in the collector loop. The frequency is determined by setting the imaginary

THE NATIONAL SCENE



KEEPING "ELECTRONIC BRAINS" FROM LOSS OF MEMORY. One of science's greater marvels is IBM's 705 Electronic Data Processing Machine—which makes intricate calculations and logical decisions in millionths of a second. Heart of this electronic "wizard" is its main magnetic core memory. Designed for use with the machine's high-speed printer is the IBM 760 Control and

Storage Unit containing its own core memory of 1,000 positions which allows central processing to continue in the 705 while other data are being printed. Helping the 760 remember what information is to be printed is a job for PHENOLITE® Laminated Plastic. PHENOLITE's unique combination of properties makes it ideal for this application.

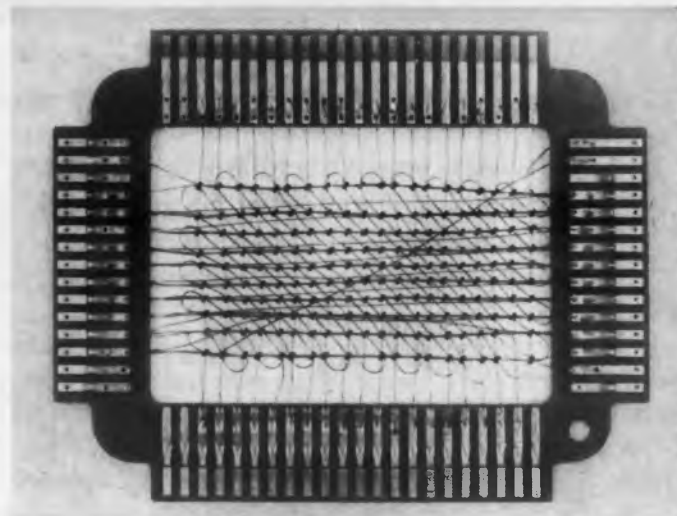


MOST ADVANCED FORM OF ELECTRONIC STORAGE. The 1,000-position core memory for the IBM 760 Control and Storage Unit—a portion of which is shown here—consists of pinhead size cores strung on copper-wired frames of PHENOLITE. Electrical impulses, passing through wires, alter the magnetic state of cores so that a group of them stands for a word or figure. Reversing the process recalls information from storage. PHENOLITE frames safeguard the circuit and permit stacking of core planes as shown.

NATIONAL CAN HELP YOU reduce unit product cost or improve product performance at no added cost. Here's why . . . You can select the "one best material" from over 100 grades of PHENOLITE, Vulcanized Fibre and National Nylon—without compromise in properties or cost. You can simplify production and purchasing with the timed delivery of 100% usable parts—from a single reliable source. You gain competitively with National's new materials and grades—the direct result of programmed materials-research.

You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware. Dept. E-7.

CIRCLE 383 ON READER-SERVICE CARD



PHENOLITE MEETS CRITICAL STANDARDS. Core frames like the one shown are punched out of laminated PHENOLITE by IBM. Each frame has printed circuit type terminal strips and soldered connections. PHENOLITE proves an ideal material for this application because it is mechanically strong and stiff, punches cleanly, etches well, remains flat, has high dielectric properties and withstands the heat of dip soldering.



NATIONAL
VULCANIZED FIBRE CO
WILMINGTON 99, DELAWARE

In Canada:

NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

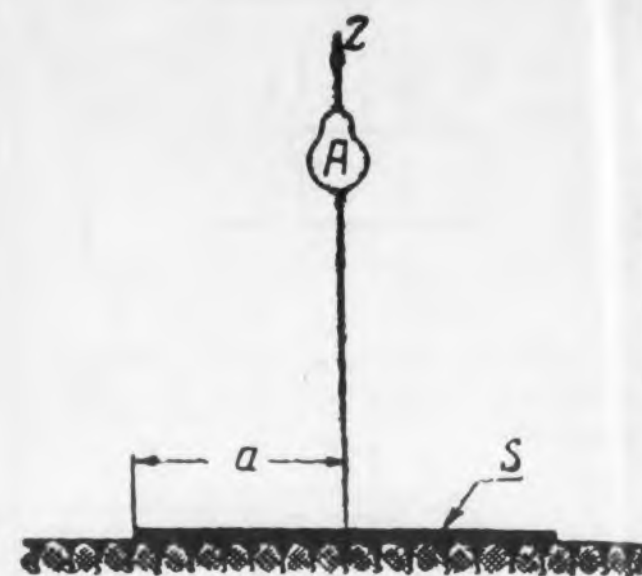


Fig. 3. The current distribution is specified in a region A above the surface $z = 0$, part of which (region S) is metallized, and the remainder of which obeys the Leontovich boundary conditions.

part of the voltage gain equal to zero, and the self-excitation conditions are obtained by setting its real part equal to unity. Expressions are derived for the various circuit impedances, and their values are compared with experimental data on several Russian transistors.

OSCILLATORS

Simultaneous Generation of Two Frequencies in a Self-Bias Self-Excited Oscillator, G. M. Utkin, (3 pp, 2 figs.).

Earlier articles by the same author, in Radiotekhnika of October 1956 (*ED*, July 1, 1957) and in January 1957 Radiotekhnika i Elektronika (*ED*, September, 1957) dealt with self-excited systems with two degrees of freedom operating at multiple frequencies, and with the mutual synchronization of self-excited oscillators at multiple frequencies. This article shows that both multiple and asynchronous simultaneous oscillations can be produced in a similar self-bias self-excited oscillator, provided the self-bias element has a low time constant.

INFORMATION THEORY

On Certain Fundamental Concepts in the Theory of Signals, V. V. Furduev, (7 pp).

The author proposes to use, as the basic signal-theoretical concepts, definitions of the correlation function and of the spectrum given in terms of the operations of averaging with respect to time. He then proceeds to show that the laws governing these concepts can be extended to include a greater class of homogeneous signals than the conventional stationary processes defined in probability theory. The autocorrelation function and the spectrum of an a-m signal are used as ex-

...ples. A distinction is made between physical and statistical spectra of signals.

ANTENNAS

...e of Fictitious Magnetic Current to Solve the Problem of Radiation from an Antenna Over a Plane, Subject to the Leontovich Inhomogeneous Boundary Conditions, C. N. Tereshin, (9 pp).

The statement of the problem is illustrated in Fig. 3 and the "Leontovich boundary conditions" define an inhomogeneous region, outside the region S, in which E_{tan}/H_{tan} is a constant. The author employs classical analysis and evaluates the integrals involved by the saddle-point technique. The stratagem of superimposing a fictitious surface magnetic current on the separation boundary between two media, is reminiscent of the double-layer potential method, widely used in electrostatics.

CIRCUIT THEORY

...ncerning the Synthesis of Amplifier Circuits, V. Samsonenko, (14 pp, 6 figs.).

The mathematical difficulties in the synthesis of amplifier circuits by operational calculus can be eased somewhat by using orthogonal polynomials. The author employs expansions in Hermite polynomials to derive equations for the quantities needed to synthesize amplifier circuits, such as rise time, amplitude of first overshoot, and maximum slope of transient curve. This also simplifies considerably the calculation of the transient response, particularly in multi-stage amplifiers. Considerable space is devoted to the mathematics of Hermite polynomials.

MICROWAVES

...n Certain Fundamental Relationships in High-Power Klystron Amplifiers, M. S. Neiman, (10 pp, 3 figs.).

Klystron high-power amplifiers would be used more extensively were it not for the fact that they require very high supply voltages, have narrow bandwidths, and the dimensions of the klystron accelerators become too large at waves longer than 50-60 cm. The causes of the above shortcomings are analyzed and partial remedies are suggested. Special attention is paid to the analysis of the limitation of the output bandwidth and to the minimum usable supply voltage.

Other Articles in This Issue

...n Smoothing Filters for Low-Power Rectifiers, L. Dekabrun, (6 pp, 6 figs.).

...pproximate Methods for Calculating the Field Intensity of UHF Radio Waves with Allowance for the Local Topography, A. I. Kalinin, (9 pp, 6 figs.).

**you get fast delivery
on these**

BROWN COMPONENTS

for instrument, servo or control circuits



**NEW!
Brown
Motors***

for chart drives, servos, balancing circuits

These newly-designed synchronous and two-phase Brown motors have many maintenance saving features: new, sectioned die-cast housing . . . new wicking to prevent oil leakage . . . printed circuits . . . ball bearings to reduce friction. You can replace any part in two minutes, usually without disconnecting the leads from your installation.

TWO-PHASE INDUCTION

Nominal No Load RPM†	Gear Ratio	Intermittent Rated Load (oz.-in.)	Max. Starting Torque (oz.-in.)	Power (watts) Loaded††	Current (amps) Loaded	Temp. Rise Deg. F.
330	44:1	4	10	7.6	.11	70
148	10:1	5	20	7.0	.11	70
44	30:1	15	60	7.6	.11	70
22	60:1	30	120	7.6	.11	70

SYNCHRONOUS

RPM†	Gear Ratio	Pull-in Torque, Min. (oz.-in.)	Continuous Torque (oz.-in.)	Power (watts) Loaded	Current (amps) Loaded	Temp. Rise Deg. F.
180	10:1	12	12	19	.21	100
180	10:1	3.5	4	13	.11	65
90	20:1	14	12	11	.095	55
60	30:1	13.5	12	13	.11	65
30	60:1	27.5	12	13	.11	65

†1/6 less at 50 cycles. Some speeds available at 25 cycles.

††6.0 watts in field winding, balance in amplifier winding.



BROWN Electronik AMPLIFIERS*

Amplify a d-c or a-c microvolt input signal sufficiently to drive one field of a two-phase balancing motor. Brown amplifiers have extremely low stray pickup, excellent stability, adjustable sensitivity and fast response. Proved in thousands of Electronik instruments.

SELECT FROM THESE BASIC MODELS

Nominal Gain	Sensitivity (Microvolts)	Nominal Input Impedance (Ohms)
1×10^6	4.0	370, 1400, 50,000
4×10^6	1.0	370, 2500
12×10^6	0.4	2500
40×10^6	0.1	1400

POWER SUPPLY

115 v., 60 cycles (fused power line)

OUTPUT

2 to 18 ma. into 12,000 ohm load

SENSITIVITY

Continuously variable screwdriver adjustment. Recessed slot protects setting

MOUNTING

Operation unaffected by mounting position

OPTIONAL FEATURES

(a) thermocouple burn-out protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles, (h) 220-110 volt transformers.

*The sale of this device does not carry with it a license under any of our combination patents covering apparatus in which this device may be used.

For additional details, call your nearby Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR Co., Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell



First in Controls

Video Coupling Network Nomogram

J. George Adashko



AN RC-coupled video amplifier tilts the flat top of a rectangular pulse, and if the frequency response curve of the amplifier has a steep slope in the low-frequency region, i.e., if the time constant of the coupling network is small, the output pulse has a negative "tail." With this nomogram, it is possible to calculate the time constant of the coupling network, given the pulse duration and the permissible inclination of the flat top of the input pulse. In addition, it is also possible to determine the lower frequency limit (f_L), at which the frequency response curve has a slope of 3 db.

The nomogram is based on the equations

$$RC = \frac{\tau}{\ln \frac{1}{1-k}}$$

$$f_L = \frac{1}{2\pi RC}$$

Here k is the droop in the top of the pulse, relative to the pulse amplitude, τ the duration of the pulse in seconds, R the grid-leak resistance in ohms, C the coupling capacitance in farads. The values of τ and k are found on the outer scales of the nomogram and joined with a straight line. RC and f_L are read on the intersection of this line with the middle scale.

Example: For a 50-cycle (pulse duration $\tau = 10,000 \mu\text{sec}$) to have a maximum slope $k = 2\%$ it is necessary for the coupling network to have a time constant $RC = 0.47 \times 10^6$ ohm-microfarad and $f_L = 0.35$ cycles.

From "Nomogram Collection on Radio Engineering," V. M. Rodionov, Soviet Radio Publishers.

TAKING STOCK IS GOOD BUSINESS

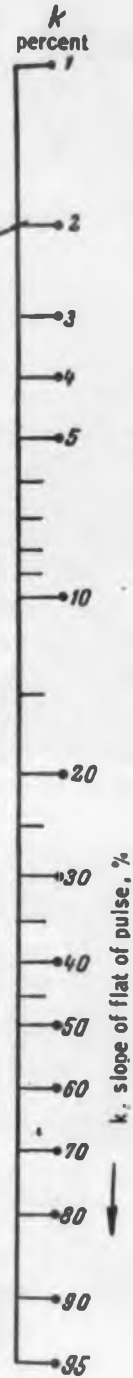
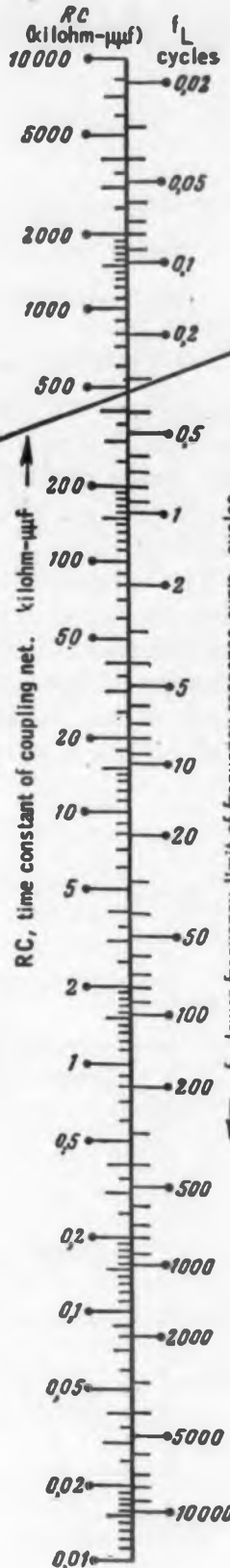
If you're in business, you take inventory at least once a year. It's essential to the health of your business to know where you stand. But have you taken stock of yourself recently? Do you know where you stand when it comes to cancer?

A once-a-year health checkup can tell you. The chances of curing cancer are far greater when it is detected early and treated promptly. Living proof are the 800,000 Americans who *have been cured*.

Yet lung cancer now kills 24,000 men annually...eight times as many as twenty years ago. And thousands of these deaths could have been prevented *if the cancer had been diagnosed early and treated promptly*.

That's why it's vital for every man to have a health checkup every year, including a chest x-ray. Further, if a cough or hoarseness lingers for more than two weeks — one of cancer's danger signals — an immediate visit to the doctor is indicated. Give yourself the same break you give your business. Take that personal inventory regularly — have a health checkup every year.

AMERICAN
CANCER
SOCIETY



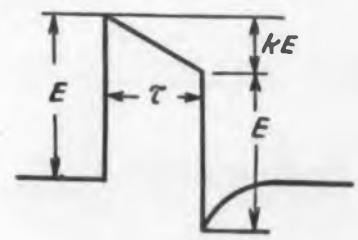
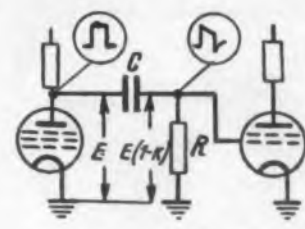
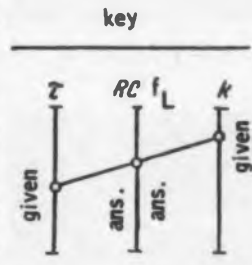
equations

$$RC = \frac{\tau}{\ln \frac{1}{1-k}}$$

$$f_L = \frac{1}{2\pi RC}$$

Example
given

$k = 2\%$
 $\tau = 10^4 \mu \text{ sec}$
 we get:
 $RC = 0.47 \cdot 10^6 \text{ ohm} \cdot \mu \text{ f}$
 $f_L = 0.35 \text{ cy}$



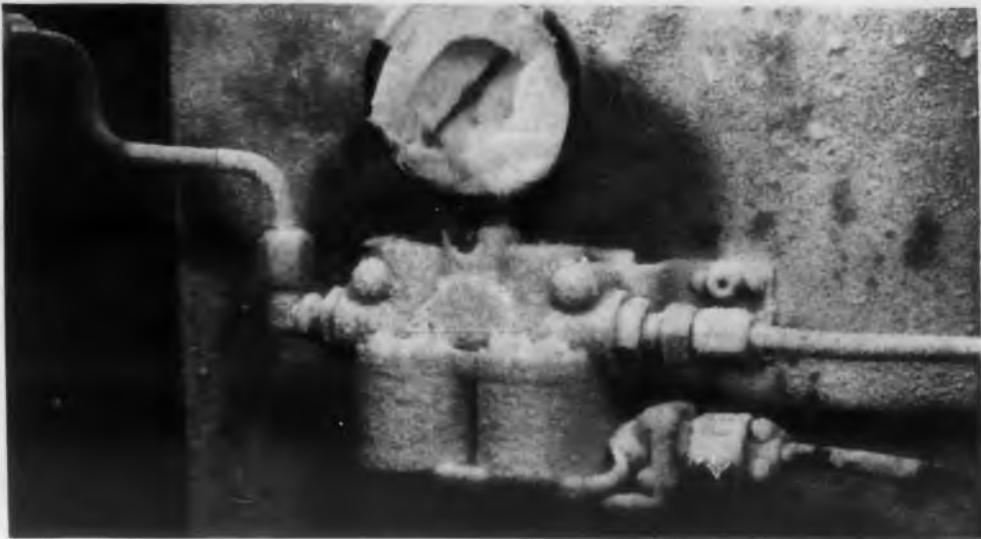
at to
 rency
 ope
 nsta
 puls
 is pos
 uplin
 ermit
 puls
 ie th
 uene

duration of pulse, $\mu \text{ sec}$

relative
 puls
 ms, C
 s of
 ogran
 e rea
 nidd

τ
 % it
 a tim
 and f

Eng
 isher



FREEZE-UP of solenoid-controlled valve in airborne system at -65°F can choke off vital air supply. Manufacturer faces tight contract delivery schedule.



SPECIAL HEATING unit custom-designed and delivered by G.E. in 5 days enables stock valve to function properly, saves customer time, money.

AIR VALVE OPERATING AT -65°F SHOWS HOW ...

General Electric Specialty Heating Maintains Component Temperature

When components must be kept at operating temperature, G-E specialty heating equipment does the job! Thermal conditioning applications ranging from hydraulic and electronic components to tiny test instruments have all been solved by experienced G-E heating engineers.

LET US ANALYZE YOUR HEATING PROBLEM. Whether it's fast delivery on a prototype or quantity production, General Electric can provide specialty heating products engineered to your specific component needs.

FOR MORE INFORMATION contact your local General Electric Apparatus Sales Office or send coupon.

General Electric Company
Section Q 220-12, Schenectady 5, N. Y.

Please send bulletin GEA-6285A, G-E Specialty Heating Equipment

.....for immediate project
.....for reference only

Name

Position

Company

City State

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 386 ON READER-SERVICE CARD

LOOK

in this book...
over 7,000
**STAINLESS STEEL
FASTENINGS**

RIGHT-OFF-THE-SHELF™
for immediate delivery

STAINLESS STEEL

- Bolt & Cap Screws
- Socket, Set & Cap
- Nuts, Washers
- Machine Screws
- Sheet Metal Screws
- Wood Screws
- Pipe Fittings
- Dowel, Taper, Cotter Pins
- AN Drilled Fillisters
- Stud Bolts

- Avoid costly production and experimental delays!
- Brand new edition of Star Catalog now available.



Write, wire or phone for your copy today!

Stainless Stan says "Star's screws have clean, bright-and-shiny heads!"



STAR STAINLESS SCREW CO.

663 Union Blvd., Paterson 2, N.J.
Telephone: Little Falls 4-2300
Direct New York phone: Wisconsin 7-9041
Direct Philadelphia phone WA 5-3660

CIRCLE 451 ON READER-SERVICE CARD

7 Sound Reasons
for using **KULKA TERMINAL BLOCKS**
on your Electronic Equipment



- ✓ Eliminate Splicing
- ✓ Stop leaks and Shorts
- ✓ Increase Insulation
- ✓ Make Better Connections
- ✓ Reduce Assembly Work
- ✓ Quality Blocks at Low Cost
- ✓ Assured Supply Source

MADE IN VARIED STYLES AND SIZES UP TO 26 TERMINALS.
WRITE FOR ILLUSTRATED BULLETIN.

KULKA

ELECTRIC MFG. CO. INC.
MOUNT VERNON, N. Y.



CIRCLE 387 ON READER-SERVICE CARD

German Abstracts

Band Pass Surface Waveguide

A SURFACE waveguide which is constructed by alternating metallic with dielectric discs as shown in Fig. 1 exhibits band pass characteristics. The thickness of the discs is small compared to the guided wavelength. To insert this structure into a coaxial system the coupling scheme (Fig. 2), given by Goubau (Jour. Appl. Phys. Vol 21, p 1119) is used. The input and output funnels are the continuation of the outer conductor of the coaxial cable and the inner conductor of the cable is widened to the diameter of the surface guide by means of the metallic cone. The dielectric filament which is used to assemble the discs is ignored in calculation.

The solution of the field equations shows

that the pass and stop regions of the resulting filter are given by

$$\text{pass regions: } w_n < \omega \sqrt{\mu_0 \epsilon} a < v_n$$

$$\text{stop regions: } v_n < \omega \sqrt{\mu_0 \epsilon} a < w_{n+1}$$

where w_n are the zeroes of first kind zero order Bessel functions (J_0) and v_n are the zeroes of first kind first order Bessel functions (J_1). These results apply for the E-waves (TM).

The attenuation of this structure was also calculated, the result for the first pass band is shown in Fig. 3.

Abstracted from an article by D. Marcuse, Archiv der Elektrischen Uebertragung, Vol. 11, No. 4, April 1957, pp 146-148.

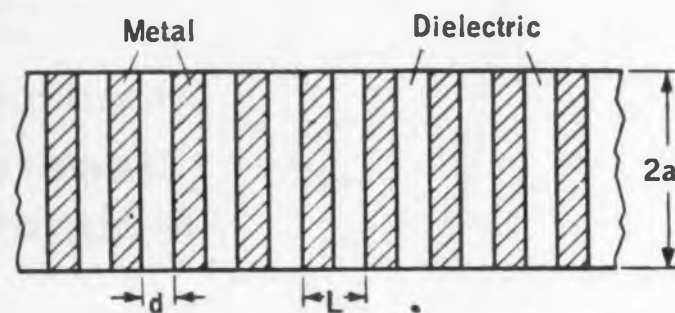
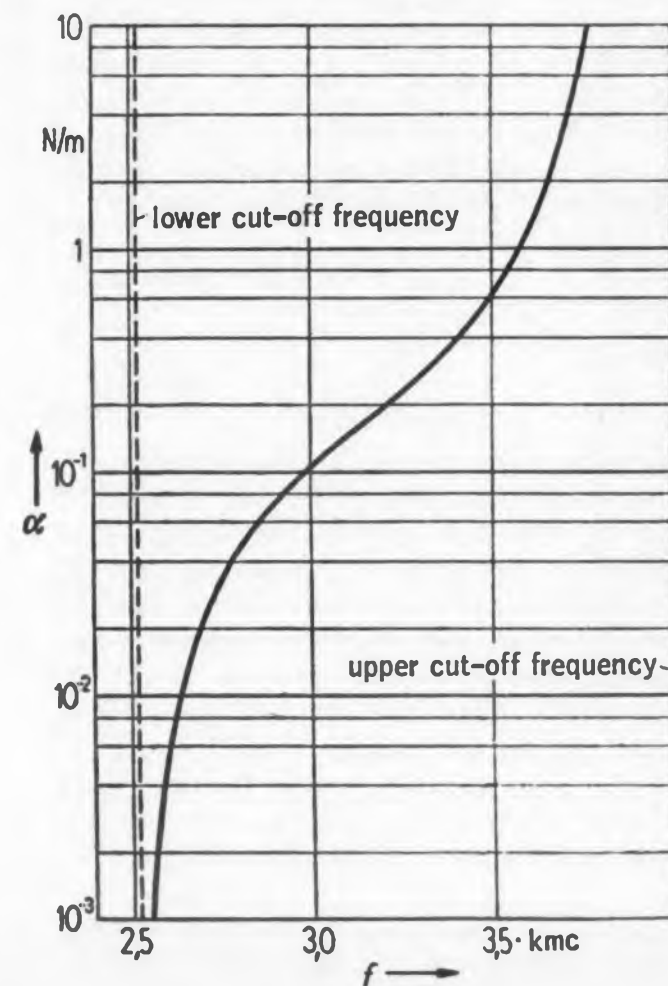


Fig. 1. Construction of the waveguide.



Fig. 2. Coupling scheme for coaxial system.

Fig. 3. (right) Attenuation characteristics in the first pass band. Dimensions: $a = 2.75$ cm, $L = 1.2$ mm, $d = 0.60$ mm. Conductivity of metal discs 3.3×10^5 mhos/cm, loss tangent = 0.005, and $\epsilon/\epsilon_0 = 2.75$



Pulse Type Cathode-Ray Tubes

THE luminescence and resolution of cathode ray tubes increases with increasing anode voltage while the deflection sensitivity decreases. The conventional method used to furnish high intensity is the post-accelerating anode system shown in Fig. 1. While the decrease in sensitivity due to post-acceleration is less than what would be obtained were the anode voltage increased to obtain the same intensity, this system introduces considerable distortion into the raster so that the ratio of post to second anode voltage must be kept below 2.

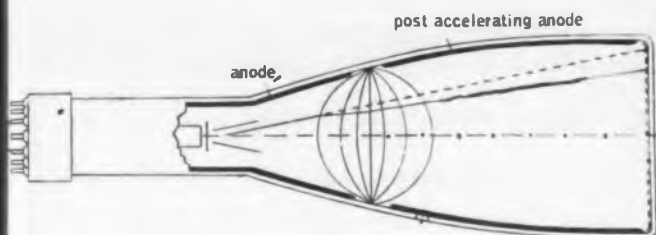


Fig. 1. Conventional post accelerating system. The solid line shows the trajectory with post acceleration, the dotted line shows that path taken without post acceleration.

A spiral resistive coating introduced as the post accelerating anode, as shown in Fig. 2, results in an almost linear field increase (development of Tektronix and Dumont). By critically choosing the distance at which the spiral starts, measured from the end of the deflection plates (A), the distortion can be eliminated independently of the accelerating voltages over a wide range.

Abstracted from an article by E. Gundert and W. Schaffernicht, Elektronische Rundschau, Vol. 11, No. 4, April 1957, pp 107-108.

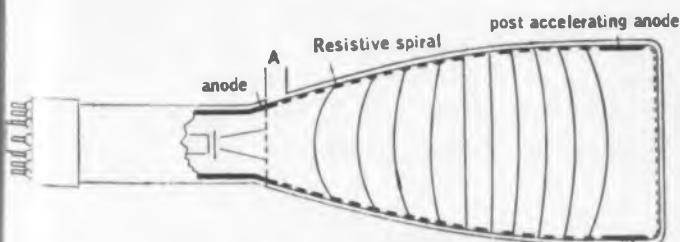


Fig. 2. Cathode ray tube with resistive spiral coating for post acceleration.



"INDIUM"

prepared to your specifications . . .

Indium or indium alloys in ingots, sheets, wire, powder, ribbon, and pellets (disc or spherical) are supplied by us to leading U.S. manufacturers of electronic equipment. These and other forms prepared to your own requirements are available in two grades:

Tadanac High Purity - approximately 99.999% In

Tadanac Standard Grade - guaranteed 99.97% In

As one of the world's leading primary producers of indium, we apply the services of our Research and Development Division to assist our customers in obtaining the full benefits of this most versatile metal.

Other high purity TADANAC BRAND METALS
Zinc - 99.9995% Lead - 99.9998%
Bismuth - 99.9998% Cadmium - 99.9999%
Silver - 99.9999%

Our prices include custom's duties, and we handle all customs procedures.

For further information or quotations contact:

COMINCO

THE CONSOLIDATED MINING & SMELTING COMPANY OF CANADA LIMITED

Metal Sales Division

215 ST. JAMES STREET WEST, MONTREAL, CANADA

5762-ME

CIRCLE 452 ON READER-SERVICE CARD

TRU-OHM PRODUCTS

America's TOP Line



MIDGET OVAL VITREOUS ENAMELED RESISTORS

Supplementing the TRU-OHM standard line of oval resistors is the MIDGET OVAL which is desirable where size is most important and must be kept to a minimum. Available in three sizes from 1,700 to 8,000 maximum resistance. We invite your inquiry.

As the world's largest producers of wire-wound resistors, we suggest you specify TRU-OHM for any and every type of resistor.

TRU-OHM Power Rheostats

Available from 25 to 150 watts for any and every application . . . from stock or designed to meet your most exacting needs.

We always ship on time
... and we expedite for you

Our new catalog is available
... your copy is now available

General Sales Office: 2800 N. Milwaukee Ave., Chicago 18, Ill.
Factory: Huntington, Indiana

MANUFACTURERS: Power Rheostats,
Fixed Resistors, Adjustable Resistors,
"Econohm" Resistors, "Tru-rib" Resistors

TRU-OHM PRODUCTS

Division of
Model Engineering & Mfg., Inc.

CIRCLE 388 ON READER-SERVICE CARD

PHAZOR PHASE METER

Pat. Pend.



MODEL
200 A

PRICE
\$349.50
F.O.B.
NEW YORK

- HIGH ACCURACY
- MEASURES FROM 0 TO 360 DEGREES
- READINGS NOT AFFECTED BY NOISE AND HARMONICS
- PHASE SHIFTS OF THE ORDER OF .01° CAN BE MEASURED EMPLOYING SPECIAL CIRCUIT TECHNIQUES
- MEASURES IN-PHASE AND QUADRATURE COMPONENTS SEPARATELY

For further information contact your nearest representative or write for brochure

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th ST. · NEW YORK 3 · GR. 3-4684

CIRCLE 390 ON READER-SERVICE CARD

Standards and Specs

Sherman H. Hubelbank

Temperature Rating

AIEE No. 1, GENERAL PRINCIPLES UPON WHICH TEMPERATURE LIMITS ARE BASED IN THE RATING OF ELECTRIC EQUIPMENT, JUNE 1957 (SUPERSEDES FEBRUARY 1954 ISSUE)

The principal objective of this revised standard is to enable the temperature classification and selection of insulating systems to be made more independently. The classification can then be based upon the results of thermal evaluation tests instead of merely on the composition of the materials. The provisions in the 1954 edition with regard to temperature measurements are retained with very slight changes but the information on limiting temperatures and the basis of rating has been extensively revised and re-arranged.

Capacitors

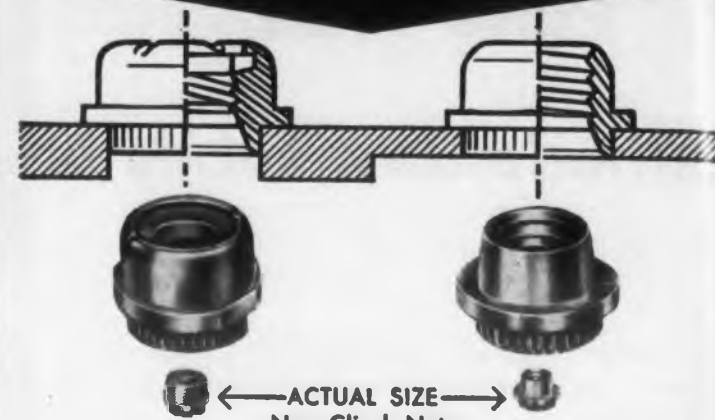
MIL-C-14157A, CAPACITORS, FIXED, PAPER (OR PAPER-PLASTIC) DIELECTRIC, DIRECT CURRENT, HIGH RELIABILITY (HERMETICALLY SEALED IN METALLIC CASES), 10 SEPTEMBER 1957

High reliability, direct current, fixed capacitors having a dielectric of paper or paper-polyester film (polyethylene terephthalate) are covered by this spec. These capacitors are primarily intended for filter, by-pass, and blocking purposes in circuits where the a-c component of the impressed voltage is small with respect to the d-c voltage rating, and where higher orders of reliability are required. Qualification inspection is required.

MIL-C-12889A, CAPACITORS, BY-PASS, RADIO-INTERFERENCE REDUCTION, PAPER DIELECTRIC, AC AND DC (HERMETICALLY SEALED IN METALLIC CASES) GENERAL SPECIFICATION FOR, 30 AUGUST 1957

This spec covers the general requirements for by-pass, radio-interference reduction, a-c and d-c paper dielectric capacitors, hermetically sealed in metallic cases. These capacitors are for use primarily in broadband, radio-interference suppression applications. The individual styles are covered by three detail specs.

New ESNA miniatures flush mount in thin stock



When space requirements are tight, one of these two new ESNA miniature clinch nuts may be just what you're looking for! They are easily flush mounted in sheet as thin as .030".

Type NCFM clinch nut for temperatures up to 350°F, has special nylon locking insert which will not gall screws or create the cadmium flaking so damaging to electrical circuitry. Type LHCFM is an all-metal nut with an elliptical crown locking device capable of withstanding up to 550°F.

Detailed dimensional drawings on these two new miniature nuts, plus full data covering necessary installation tools are now available. Write Elastic Stop Nut Corporation of America, Dept. S8-1157, 2330 Vauxhall Road, Union, N. J.



**ELASTIC STOP NUT CORPORATION
OF AMERICA**

CIRCLE 392 ON READER-SERVICE CARD

attention authors

Because an electronic design engineer must have hundreds of ideas to draw upon for each individual design decision, the editorial staff of *ELECTRONIC DESIGN* is continually trying to add to this storehouse of ideas. We are, therefore always interested in material based on your own experience which would be of immediate practical use to electronic design, development and research engineers. It is not difficult to write an article for *ELECTRONIC DESIGN* if you know what to write about and how we like to have our stories written. To simplify the preparation of an article, we have drawn up a brief guide for authors. Send for your copy today.

Edward E. Grazda, Editor.

ELECTRONIC DESIGN
19 East 62nd Street
New York 21, New York

ELECTRONIC DESIGN • November 15, 1957

FREE send for the
most widely used
ELECTRONIC SUPPLY GUIDE

**ALLIED'S
COMPLETE 404-PAGE
1958 CATALOG**

send for it!

your buying guide to the world's largest stocks
of **ELECTRONIC SUPPLIES FOR INDUSTRY**

- Receiving Tubes
- Power & Gas Tubes
- Diodes & Transistors
- Relays & Switches
- Test Instruments
- Meters & Supplies
- AN Connectors
- Metal Chassis Bases
- KNIGHT Public Address Systems

Simplify and speed your purchasing of electronic supplies and equipment at ALLIED. We make fast, expert shipment from the world's largest stocks of everything in Electronics. Manufacturers' prices available on quantity purchases. Send today for your FREE 1958 ALLIED Catalog—the complete Buying Guide to Electronic supplies for Industrial and Communications use.

One Complete Dependable Source for Everything in Electronics

ALLIED RADIO
100 N. Western Ave., Dept. 69-17
Chicago 80, Illinois



our 37th year

Send for
**FREE
Catalog**

CIRCLE 391 ON READER-SERVICE CARD

TINY CONVENIENCE OUTLETS

Give your portable appliances, radios, power tools, electronic test gear greater utility and ease of use.

Easy to install — takes absolute minimum of space.

OUTLETS, RIVETS OR SPOT WELDS RIGHT TO CHASSIS



Simple panel punch-out
Drops into place fast
Minimum space back of panel



SOLDER TAB Mini-SpAcE Outlet — with solder tabs UL approved for 15 amps @ 125V or 10 amps @ 250V. Specify #402ACE.

PRE-WIRED Mini-SpAcE Outlet — with leads automatically attached to each contact and assembled into molding. #402ACC with 16 gage wire UL approved up to 1100 watts. #402ACL with 14 gage wire, UL app. for 15 amps @ 125V or 10 amps @ 250V. Specify part number and lead lengths.

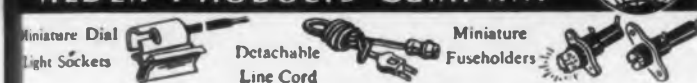
PARALLEL-WIRED Mini-SpAcE Outlet — with two leads automatically attached to each contact and assembled into molding. Ideal for parallel wiring of multiple outlets. Specify #402AC2C for 16 gage leads, #402AC2L for 14 gage leads. Give part number and lead lengths.

GROUNDING — Simply slip Alden Grounding Adapter Plate over any of above Alden Mini-SpAcE outlets and adapt it to accommodate the UL 3-prong, parallel blade, grounding plugs. Add "G" to part numbers above (e.g. #402ACEG) or order separately as #CS402ACG.

Order by number — Samples sent free

11130 N. MAIN ST., BROCKTON 64, MASS.

ALDEN PRODUCTS COMPANY



CIRCLE 394 ON READER-SERVICE CARD

(ADVERTISEMENT)

New Sola CV Transformer Design

Reduces External Field and Weight

Through a recent design improvement, Standard Type Sola Constant Voltage Transformers now offer a 90% reduction in external field and up to 53% lighter weight. In applications employing "magnetic field-sensitive" electronic equipment, such as high-gain audio circuits, the new Sola CV design may be mounted close to such components; usually magnetic shields may be eliminated.

The Sola Constant Voltage Transformer, a static-magnetic stabilizer, provides automatic instantaneous voltage regulation with $\pm 1\%$, even with primary voltage swings of $\pm 15\%$. It has no moving parts, and no manual adjustments or maintenance is required. The new Standard Type Sola CV Transformer is available in 7 capacities ranging from 30 va to 1000 va. All performance features of the former unit have been retained. Write on your letterhead for Bulletin F-CV-170E.



SOLA ELECTRIC CO.

633 West 16th Street • Chicago 50, Illinois

CIRCLE 395 ON READER-SERVICE CARD

Couplers

MIL-C-15370A, COUPLERS, DIRECTIONAL (COAXIAL AND WAVEGUIDE), AMENDMENT 1, 23 AUGUST 1957

The alternate test for effective directivity has been clarified. The requirements for packaging have been modified in accordance with the latest agreements reached by the Armed Services Packaging Group.

Insulation

MIL-I-19917(SHIPS), INSULATION SHEET, ELECTRICAL, MICA PAPER, SILICONE BONDED, 18 JUNE 1957

Requirements are established in this spec for silicone bonded mica paper electrical insulation intended for use with and in the construction and repair of commutator segments, slot cells, barriers, ground insulation, and other applications for electrical equipment operating at high temperatures.

MIL-W-3795A, WIRE, ELECTRICAL (TINSEL), 30 JULY 1957

This revision, which supersedes MIL-W-3795 dated 8 August 1952, covers uninsulated tinsel electrical wire used in the manufacture of tinsel electrical cord, where extreme flexibility is required.

MIL-I-3930A, INSULATING AND JACKETING COMPOUNDS, ELECTRICAL (FOR CABLE, CORD, AND WIRE), 16 JULY 1957

The general composition and the physical, chemical, and low-temperature properties, of certain elastomeric compounds used in the insulating and jacketing of electrical cable, cord, and wire are covered. Not covered are compounds for hook-up wire and items where the wall thickness of the insulation or jacket is less than 0.006 inch.

Cathode Ray Tubes

EIA RS-193, RETMA-NEMA STANDARDS FOR DESIGNATION SYSTEM FOR CATHODE-RAY TUBES, JULY 1957

This standard, formulated by the Joint Electron Tube Engineering Council, has assigned type designations to cathode-ray tubes. The designation consists of three groups of symbols and one or more suffix letter symbols if required. Copies of this standard are available from the Electronic Industries Association (formerly RETMA), 11 West 42nd Street, New York 36, N.Y., or the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N.Y. for 25 cents per copy.



do
you
want
to...



GENERATE PULSES



DELAY PULSES



WIDEN PULSES



REGISTER PULSES



COUNT PULSES



SUM PULSES



DO BINARY LOGIC



DRIVE TRANSISTOR CIRCUITS

You can do all of these functions with the new integrated line of NAVCOR transistorized pulse programming equipment . . . available in miniaturized building blocks.

Send for free data file!

Navcor

NAVIGATION COMPUTER CORP.

1621 SNYDER AVE., PHILADELPHIA 45, PENNA. / HOward 5-7700

CIRCLE 397 ON READER-SERVICE CARD

LATEST NEWS ABOUT ELECTRONIC PRODUCTS FROM SUPERIOR TUBE

NICKEL CATHODES FOR ELECTRON TUBES. Now five *Cathaloy** available. Exclusive Superior Tube alloys. They simplify selection, prolong tube life, greatly improve performance. Also six other standard alloys, plus special alloys as requested.

DISC CATHODES FOR TV PICTURE TUBES. Three types: standard narrow neck to permit shortening the tube and reducing neck diameter, and miniature for 3-gun color TV picture tubes. All with "E" dimension controlled to $\pm .0005$ in.

GLASS SEALING ALLOYS. Wide choice of metals for virtually any type glass. Many special alloys available on order. Sizes from .012 to $\frac{3}{8}$ -in. OD.

FABRICATED TUBULAR PARTS. Special facilities to do complete job of making close-tolerance tubular parts. They save you handling costs. Wide choice of different analysis metals. Just send drawing.

APERTURE MASKS.** Both round and rectangular aperture masks for color television. Produced in the cupronickel and other alloys, 500,000 holes are made in the mask by the photoetching process.



NEW FREE CATALOG. Complete information on Superior Tube electronic products. Write for your copy, plus Data Memorandum No. 5 (Aperture Masks) and Data Memorandum No. 15 (Glass Sealing Alloys). Write Superior Tube Company, 2050 Germantown Ave., Norristown, Pa.

*Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.
**Manufactured by Superior Tube Co. under license from Buckbee Mears Co., St. Paul, Minn.

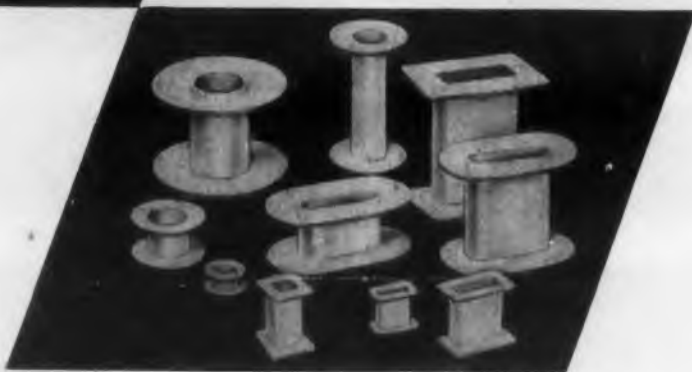
Superior Tube

The big name in small tubing
NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—
an affiliated company making precision metal stampings and deep-drawn parts.

CIRCLE 398 ON READER-SERVICE CARD

GRC small nylon coil bobbins



NOW available from stock

NOW Gries offers a wide variety of nylon coil bobbins from stock. Automatically mass produced at low cost—ready for use. Stock sizes from $\frac{1}{4}$ " diameter x $\frac{1}{4}$ " long minimum up to $\frac{7}{8}$ " diameter x $\frac{7}{8}$ " long—round, square, rectangular, oval shapes. Check Gries for your bobbin needs—either from stock—or to your size, shape and material specifications on special order.

- Wide range of shapes and sizes
- 1-pc. Nylon molding speeds winding
- Irregular shapes and special materials to order
- Accurate, uniform, ready-for-use

GRIES

GRIES REPRODUCER CORP.
WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS
40 Second Street, New Rochelle, N. Y. NEw Rochelle 3-8600
CIRCLE 399 ON READER-SERVICE CARD

Standards and Specs

Inductors

RS-197, POWER FILTER INDUCTORS FOR ELECTRONIC EQUIPMENT, 1957

Covered in this standard are iron-core, power filter inductors for use in electronic equipment where long life, reliability, and continuity of operation are essential. Included in this standard are definitions, purchase specs, performance standards, performance tests, marking data, test methods, moisture resistance tests, and corona measurements. This standard is a revision of TR-110-B. Copies of this standard are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y. for 50 cents per copy.

Capacitors

ASESA BULLETIN 183

ASESA has recently published interim interpretations and corrections of requirements and test procedures pertinent to qualification inspections of capacitors under specs MIL-C-5A, MIL-C-20B, MIL-C-25A, MIL-C-81A, MIL-C-3965, MIL-C-11272A, and MIL-C-11693A. The interpretations and corrections of requirements and test procedures are to be used for qualification purposes until such time as amendments to the pertinent specs can be promulgated officially. Copies of this bulletin can be obtained without charge from the Armed Services Electro-Standards Agency, Fort Monmouth, New Jersey.

Component Tests

MIL-STD-202A, TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS, CHANGE NOTICE 1, METHOD 106A, 31 MAY 1957

This change notice revises method 106, Moisture Resistance, dated 29 January 1953, of MIL-STD-202A, in its entirety. The paragraph concerning the purpose of the test has been expanded to clarify the intent of the test. When applicable the polarization voltage shall now be 110 volts. Initial conditioning is now specified at 50°C instead of 40°C. The relative humidity range has also been changed. An alternate method for graphical representation of moisture resistance has been added to permit use of separate chambers for performance of this test.

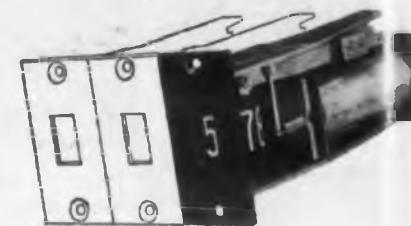
SODECO's New Type 1TD Electric Impulse Counter

For: Normal Counting . . .

Transmission of a Numerical Indication

Remote Presetting for Predetermining Control

You can use these rugged single decade counters independently as decades or interdependently as a multi-digit counter to get practical solutions to an extremely wide variety of counting problems. Ten different contact arrangements are available to solve a number of problems. For example, an interesting application is the use of any number of decades as a remote predetermined counter in which any preselected number can be set up quickly from a remote location and made to operate a signal at either or both locations when the count returns to zero. In this application, if desired the preselected figure could be set up from a punched card.



The counters are small, measuring only $\frac{7}{8}$ " x $1\frac{3}{4}$ " x $4\frac{3}{8}$ ", and are suitable for flush mounting. Fast models are available with speeds up to 25 impulses/second. Power requirements are low—permitting their installation in electronic circuits. Long lived, tests indicate certainty of operation up to at least 50 million impulses.

Complete technical data is available, including circuitry recommended for a wide range of use. Write for Bulletin 60.

LANDIS & GYR

45 West 45th Street, New York 36, N.Y.

CIRCLE 400 ON READER-SERVICE CARD



"When the time is short
and the pressure's frightening,
They serve my systems
with the speed* of lightning?"

BECKMAN/BREADBOARD PARTS

For the standard parts
to breadboard your system,
Send for catalog 115C,
where we show 'em and list 'em.

*Within 3 days of order!

Beckman/Heliopot Corporation, Newport Beach, Calif.
a division of Beckman Instruments, Inc.
Engineering representatives in principal cities.

CIRCLE 401 ON READER-SERVICE CARD



FREE

new catalog
describes

MPB

Minted Miniature Bearings

MPB has developed "coinage" techniques enabling miniature bearings to increase precision in product performance. Find out which MPB bearings will bring you the most advantages. Made in O.D.'s of 1/10" to 3/8" they're available in a wide range of types, all described in this new catalog. For design engineer's free copy of Engineering News and MPB Catalog, write to R. I. Kern, Miniature Precision Bearings, Inc., 911 Precision Park, Keene, N. H.



CIRCLE 402 ON READER-SERVICE CARD

Wire and Cable

J-C90A, CABLE, POWER, ELECTRICAL (FLEXIBLE CORD AND FIXTURE WIRE), JUNE 18, 1957

Flexible electric cords and fixture wire, except elevator cords and signal cords, are covered in this spec. The following UL Types are specified: SJ, SJO, SJT, S, SO, ST, HPD, HSJ, SP-1, SP-2, SPT-1, SPT-2, SV, SVT, C, AF, CF, TF, and TFF. A convenient table is included which cross references the type with the UL type, trade name, size, number of conductors, insulation, outer covering use.

MIL-W-5086A, WIRE, ELECTRICAL, 600-VOLT, COPPER, AIRCRAFT, 18 JUNE 1957

Covered in this spec is 600-volt single-conductor insulated copper wire for aircraft electrical use, capable of continuous operation at a maximum conductor temperature of 105°C.

Vibrators

MIL-V-95A, VIBRATORS, INTERRUPTER & SELF RECTIFYING, NOTICE 1, 9 AUGUST 1957

Spec sheet MIL-V-95/1A, entitled "Vibrator, Self-Rectifying, Type VB024S02 has been cancelled. The requirements for this vibrator are now contained in the body of the spec.

Sockets

MIL-S-12883A, GENERAL SPECIFICATION FOR SOCKETS FOR PLUG-IN ELECTRONIC COMPONENTS, AND ACCESSORIES, 27 JUNE 1957

Sockets for plug-in electronic components have been added by this revision. This revision supersedes those portions of JAN-S-28A, 28 February 1949 pertaining to electron tube sockets. Twelve new high-temperature sockets are included. Detail spec sheets have been issued instead of the previous MS spec sheets. Contact position marking is now required for all sockets. The type designator now includes both three and four digit style indicators.

Cancelled Spec

MIL-D-3054A, POLYETHYLENE DIELECTRIC MATERIAL, NOTICE 1, 23 JULY 1957

This spec, dated 11 July 1952, has been cancelled. Types N and C of MIL-D-3054A are covered by grades 4 and 5, respectively, of Federal spec L-P-590, Plastic Compounds, Molding and Extrusion, Polyethylene, dated 15 February 1957.

PIN-POINT BOTTLENECKS

TIME RECORDER + TOTALIZER

Boost production in your plant by pinpointing lost time of men and machines. TR + T provides accurate data on any machine, process, operation. Records on-off time. Gives impersonal time-study information, true cost accounting, anticipation of parts replacement. Continuous 4-month tape needs no ink. Used in nation's foremost industries. \$65 Brochure on request.

standard
INSTRUMENT CORP.
657 BROADWAY, NEW YORK

CIRCLE 404 ON READER-SERVICE CARD

Where can you use VARFLO?

(the highly flexible Class B Sleeving and Tubing that licks Class A in performance—equals it in price)

- MORE FLEXIBLE**—can be bent over heat in kinks without cracking or creasing.
- MORE RESISTANT** to water, alkalis, mild acids, common solvents, oils and greases.
- LONGER LASTING** at high temperatures—withstanding hundreds of hours at 300° F.
- INHERENTLY STRONGER**—stands up under vibration, varnishing, baking. Good shelf life, too.
- MORE STABLE**—retains dielectric value when pulled back during soldering.
- WIDER RANGE**—available in 3 NEMA grades, 10 cal. or. coils, 36 lengths or shorter pieces.

Cuts inventory, too! Superior to Class A insulation in performance—yet on a par with it in price—Varflo Sleeving and Tubing can be used economically for all Class A and Class B installations. This low-cost adaptability of Varflo enables many of our customers to achieve substantial savings in inventory. Available in NEMA Grades A-1 and B-1 tubing and Grade C-2 sleeving.

Perhaps Varflo can solve your insulating problems. Describe them in a letter—no cost or obligation for our recommendations.

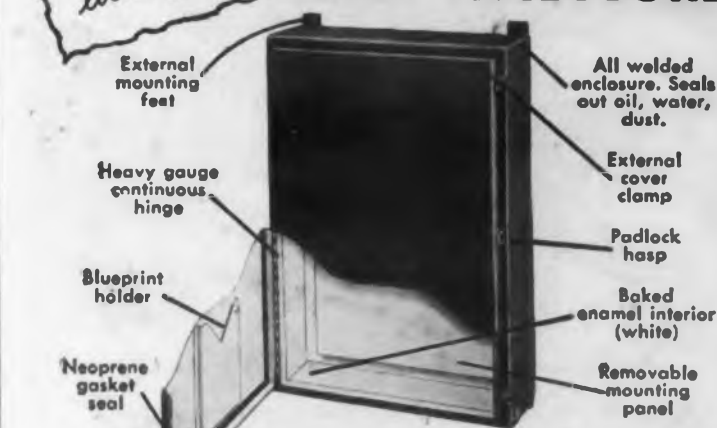
Send for **FREE Test Samples**

514 W. Court St., Rome, N. Y.

Varflex
CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

CIRCLE 403 ON READER-SERVICE CARD

Available from stock J.I.C.-NEMA Type 12 PANEL ENCLOSURES



These panel enclosures are strong, rigid, cleanly finished, and comply fully with J.I.C. and NEMA 12 specifications. No knockouts, no holes to admit oil, water, dust. We have stock sizes at low cost for fast delivery. Or, we can make any size you want. We also make J.I.C. Wiring Boxes, Troughs, Push Button Stations and Rain-proof Power Outlets. Can we help you?

STANDARD STOCK SIZES

16" x 12" x 6"	30" x 20" x 6"	36" x 30" x 8"
20" x 16" x 6"	30" x 24" x 6"	42" x 30" x 8"
20" x 20" x 6"	30" x 24" x 8"	42" x 36" x 8"
24" x 20" x 6"	36" x 24" x 8"	48" x 36" x 8"


Ask your electrical jobber or write us direct.

Hoffman ENGINEERING CORPORATION

Dept. ED-36 Anoka, Minnesota

CIRCLE 405 ON READER-SERVICE CARD

Attach it to Your Starter, NOT TO YOUR MOTOR



STOP THAT MOTOR

... INSTANTLY

with SELENIBRAKE

— the electric brake for a-c motors
— from 1/2 hp to 250 hp and up

- Far surer stops than with mechanical brake!
- Far smoother than plugging!
- Easy to install . . . with just 6 wires to starter!
- Standard unit can be supplied for single- or 3-phase use, and for explosion-proof or dust-proof motors.

WRITE FOR DATA

INDUSTRIAL RECTIFIERS
Rectifiers available for industrial and commercial applications. Write for data on your specific needs.

AMERICAN RECTIFIER CORPORATION

95 Lafayette Street • New York 13, N. Y.

CIRCLE 406 ON READER-SERVICE CARD



GEE-LAR KNOBS FOR IMMEDIATE DELIVERY

Fast Service is the big "plus" you get at GEE-LAR—the House of Knobs. Hundreds of styles, sizes and types, including deluxe Gold Inlay Knobs, are stocked . . . quickly shipped to you in any quantity. Best of all, your costs are always moderate . . . there's no charge for tooling or molds.

FAST SERVICE
Gee-Lar is geared for immediate deliveries. Get the facts today.

KNOBS FOR
Television • Home Radios
Phonographs • Clock Radios
Auto Radios • Instruments . . . many others.

GEE-LAR MFG. CO.

Division of G-C - Textron Inc.
400 South Wyman Street • Rockford, Illinois

WRITE today for your big, free illustrated Gee-Lar Catalog. No obligation!

Standards and Specs

Identification Plates

MIL-P-15024B(SHIPS), PLATES, IDENTIFICATION-INFORMATION AND MARKING FOR IDENTIFICATION OF ELECTRICAL, ELECTRONIC, AND MECHANICAL EQUIPMENT, AMENDMENT 2, 11 MARCH 1957

Embossed plates made of aluminum must be anodized. The illustrations of identification plates for electronic equipment covering combination set and unit, group, and unit for limited space and airborne equipment have been revised.

Resistors

MIL-R-94B, RESISTORS, VARIABLE, COMPOSITION, GENERAL SPECIFICATION FOR, 30 JULY 1957

The five styles formerly included in the body of the basic spec are now covered by detail specs. Characteristics T and V have been deleted. Characteristic X, specifying an operating temperature of 70°C at rated wattage, has been added. Tests and requirements for acceleration, shock, and high frequency vibration have been added. Changes have been made in power ratings for style RV2 and RV6. Shaft styles FE and FG have been deleted and style Fk is now to be used only for replacement. Shaft style SL has been added.

RS-196, FIXED FILM RESISTORS, SEPTEMBER 1957

Requirements are established for a film-type resistor distinguished, in general, by its accuracy of initial tolerance and stability under the standard tests outlined. A typical type designation of a resistor meeting this spec is RRN20. Copies of this publication are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y. for 60 cents per copy.

Equipment

MI-E-500B(ASG), GENERAL SPECIFICATION FOR AIRBORNE ELECTRIC EQUIPMENT, 24 MAY 1957

Covered in this spec are the general requirements for the design of and the manufacture of airborne electronic equipment for operation primarily in piloted aircraft. The detail performance

ACCEPTED by

- RADIO & TV SERVICEMEN
- LABORATORIES
- RADIO AMATEURS
- EXPERIMENTERS



50 Test Leads in ONE!

SMITH UNIVERSAL TEST LEADS

COMPLETELY INTERCHANGEABLE AT EITHER END!

Revolutionary — SMITH Exclusive! Threaded inserts at ends of prods and terminals permit quick interchange to meet every conceivable testing need! Available at your nearest Electronic Parts Jobber



NEWLY DEVELOPED!
Smith Binding Posts, Plugs, Jacks, as well as the complete line of

SMITH ELECTRONIC COMPONENTS

You'll find them all in the great new 40-page Catalog No. 57. Send for it today!



HERMAN H. SMITH, INC.
2326 Nostrand Avenue • Brooklyn 10, N. Y.
Telephone: CLOverdale 3-7900

CIRCLE 408 ON READER-SERVICE CARD



GLASS for HERMETIC SEALING

- EPOXY PREFORMS
- PRESSED CERAMICS

CIRCLE 409 ON READER-SERVICE CARD



HOW MUCH AIR?
WHAT PRESSURE LOSS?
WHAT TYPE OF FILTER?
WHAT SIZE FILTER?
HOW MANY FILTERS?

How Are You Going To Solve Your Electronic Equipment Ventilation Problems?

Smaller components, critical heat effects and effective dirt removal make proper ventilation of electronic equipment most important. FARR COMPANY offers a new line of air filters for electronic components that can be specially designed to meet your needs... in any size, shape, material or capacity.

More important, Farr Engineers who are among the country's leading authorities on air filtration, offer you expert assistance in your ventilation design problems.

WRITE OR WIRE FOR TECHNICAL INFORMATION OR THE SERVICES OF YOUR NEARBY FAR-AIR® FIELD ENGINEER

FARR
COMPANY

LOS ANGELES • NEW YORK • CHICAGO • NEW ORLEANS

Manufacturing Offices:
Farr Company Ltd., Ltd.
Montreal, Canada
The Clyde Engineering Co. Pty. Ltd.
Sydney, Australia
Inverell Ltd.
Birmingham, England

Originators of FAR-AIR® Certified Filter Service

CIRCLE 410 ON READER-SERVICE CARD

and test requirements for each particular equipment are covered in the detail spec for that equipment. MIL-E-25647, on the other hand, covers the philosophy of design and the more general requirements for the design and the manufacture of airborne electronic equipment and related equipment. Interesting to note that the spec MIL-E-25647 is not part of MIL-E-5400.

ANA BULLETIN NO. 400J, APPLICABLE DOCUMENTS AIRCRAFT ELECTRONIC EQUIPMENT, 24 MAY 1957

The latest effective issues of specs, standards, drawings, and publications to be used in the design and construction of airborne electronic equipment are listed in this bulletin. The use of this list is governed by MIL-E-5400.

MIL-E-19100A (SHIPS), GENERAL SPECIFICATION FOR NAVAL SHIPBOARD ELECTRONIC TRAINING EQUIPMENT, 5 JULY 1957

Covered in this spec are the general requirements applicable to the design and construction of electronics training equipment for Naval shipboard application to simulate conditions inherent in Military equipment or operational situations which it represents. The intent of this spec is to set forth the ambient conditions within which equipment must operate satisfactorily and reliably, the general material, the process for selection and application of parts, and to detail the means by which equipment as a whole shall be tested to determine whether it will so operate. Throughout design and manufacture of the equipment, maximum effort shall be made to attain basic design objectives in that equipment will meet the needs of the Naval service and to instill or increase the habits of discipline or skill in utilizing shipboard operational equipment.

MIL-P-1755D (SHIPS) PREPARATION FOR DELIVERY OF ELECTRONIC EQUIPMENT; MISCELLANEOUS ELECTRICAL EQUIPMENT (EXCEPT ROTATING ELECTRICAL EQUIPMENT) AND ASSOCIATED REPAIR PARTS, AMENDMENT 2, 2 AUGUST 1957

The title of this spec has been changed to: "Preparation for Delivery of Electronic, Electrical, and Electro-Mechanical Equipment and Associated Repair Parts." Table I, entitled "Preservation and Packaging of Electronic, Electrical, and Electro-Mechanical Equipment" and Table II, entitled "Preservation and Packaging of Electronic, Electrical, and Electro-Mechanical Repair Parts" have been revised.

The greatest connector catalog since Sears met Roebuck!



Packed with information, loaded with charts and a profusion of drawings, the new Deutsch Miniature Electrical Connector Catalog reads good, like a catalog should.

Twenty-four colorful pages herald the full line of Deutsch miniature connectors—Miniature Push-Pull, Rack and Panel, and Edgelite. Charts show contact clockings and alternate insert positions.

Get the full story on mating combinations! Thumb through charts that specify contact sizes and significant dimensions for each connector. Feast your eyes on the construction and operational features of the Deutsch miniature line.

If you're looking for miniature connectors to meet the performance requirements of advanced electronic and electrical systems, write today for this handy answer book. Ask for it by name: Deutsch Miniature Electrical Connector Catalog, Brochure 1132.



The Deutsch Company

7000 Avalon Blvd., Los Angeles 3, California

CIRCLE 412 ON READER-SERVICE CARD

SAVINGS
\$12.35
PER THOUSAND
over machine
method cost



SCREW MACHINING \$15.00 per thousand

COLD HEADED \$2.65 per thousand

Cold-Heading is the most versatile, most economical method for producing your fasteners and small parts. This case history is typical of thousands of money saving jobs we've done for our customers. May we quote on your requirements? Write today for the Hassall Catalog.

John Hassall, Inc., P.O. Box 2202 Westbury, Long Island, N.Y.

MANUFACTURERS SINCE 1850



Hassall

NAILS, RIVETS, SCREWS AND OTHER COLD-HEADED FASTENERS AND SPECIALTIES

CIRCLE 411 ON READER-SERVICE CARD

New TRINSEEL® TEFLON® sub-miniature terminals

for installation **SPEED** in 4 IN and ready to solder in 4 Seconds



"Cork" into chassis...TEFLON insulation holds and seals PERMANENTLY.

* TM Tri-Point

consistent **PERFORMANCE** 60 cps — 30,000 MC



ALL TEMPERATURES...HIGH-HUMIDITY SHOCK conditions. Insulated with special "TSI" TEFLON developed by Tri-Point.

AVAILABLE in standard sub-miniature stand-off, feed-thru sizes, fixtures, variety of pin finishes... in test or production quantities.

WRITE for Bulletins MT-157-F and MT-157-S.

© DU PONT

TRI-POINT PLASTICS INC.

176 I. U. Willets Rd. • Albertson, L. I., N. Y. MAYfair 1-5801

PIONEERS in TEFLON Extrusion...Plastics MACHINING

CIRCLE 413 ON READER-SERVICE CARD

ENGINEERS • PHYSICISTS

Big things
are happening
in

MOTOROLA'S

Chicago Civilian Research and Development Laboratories

- Industrial Communications Equipment
- Consumer Products

Here is opportunity *unlimited* for men who like challenges and the rewards that go with accomplishment in non-military engineering assignments. This is your opportunity to advance your career while working in well instrumented laboratories and enjoying the benefits from association with men of the highest technical competence. There are many liberal employee benefits, including an attractive profit sharing plan.

You'll like living in one of the beautiful suburbs of the playground of the midwest, where there are endless social, cultural, and educational activities to choose from the year-round. Exciting life or quiet life—Chicago offers either.

Salary levels are open and commensurate with ability. Directly related engineering experience is *not* needed.

POSITIONS AVAILABLE IN:

● Two-way communications • Portable communications • Radio & TV (color) • Component engineering • Transistor research and application
Microwave systems • Servo-mechanisms • Field engineering • Communications sales engineering • Field service engineering

For full discussion of these opportunities—Write:

Mr. L. B. Wrenn, Dept. J

MOTOROLA, INC.

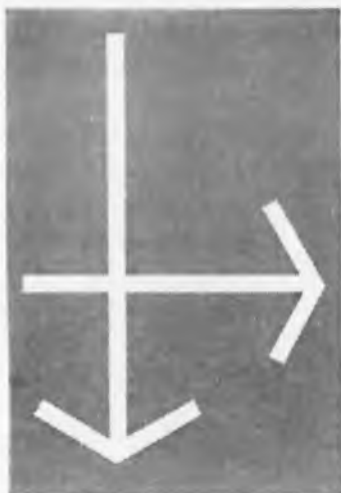
4501 Augusta Blvd., Chicago 51, Ill.



MOTOROLA

CIRCLE 550 ON READER-SERVICE CARD

Engineers - Scientists



Waltham, Mass.

At Sylvania's Waltham Laboratories, you can work on creating an integrated ground-to-air ballistic missile intercept system.

Put Your Engineering Skills to Work on VHF to UHF Projects in:

- Low Noise Receivers
- Pulse Transmitters
- Antenna Arrays
- Phase Shift & Control Devices
- Ultraprecision Instrumentation

A Degree and 1½-10 Years Experience Can Qualify You as: Engineer in Charge • Advanced Research Engineer • Senior Engineer • Engineer • depending upon experience.

For further information on opportunities in Waltham please send your resume to:

Graydon A. Thayer
100 First Avenue
Waltham, Mass.

Sylvania Offers East or West Coast Locations

Mountain View, Calif.

Openings in the following fields:

- Systems Analysis
- Systems Development
- D&D: Transmitters, receivers, components, antennas
- Data Handling
- Electronic Packaging
- Field Engineering
- Mechanical Engineering

Reconnaissance Systems Laboratory

Newest Mountain View facility offers opportunities for research, development and fabrication of military electronic reconnaissance systems for detection and surveillance of electromagnetic radiation in and around the earth.

Electronic Defense Laboratory

Research, development and fabrication of electronic countermeasures systems and equipment.

Microwave Physics Laboratory

Research and advanced development in guided microwave control devices utilizing ferrites, gaseous electronics, ferro-electrics and paramagnetic resonance.

Microwave Tube Laboratory

Research, design, development, and production of Klystron, Traveling Wave tubes and Backward Wave oscillators.

For further information on opportunities in California, please send your resume to:

J. C. Richards
P.O. Box 1296
Mountain View, Calif.



CIRCLE 551 ON READER-SERVICE CARD

Opportunity
Knocks But
Once . . .

BALDERDASH!

Opportunity seldom knocks at all. It usually doesn't even know where you live!

Unfortunately, there are a great many brilliant, deserving engineers and scientists who are patiently waiting for their "big chance" to come roaring down the street . . . bash in their front door . . . grab them by the lapels, and trundle them off to top management heaven where the big "bundle" is made.

Hold on . . . *the very fact that many engineers are deluding themselves into obscurity gives you your greatest competitive advantage in getting ahead.*

While your optimistic counterpart is futilely waiting for good fortune to crash in, all you have to do is *expose yourself* to the people who need you so badly.

Through DECISION/INC you can do this quickly, easily, thoroughly, confidentially, and at absolutely no cost. As management consultants and specialists in technical-executive recruiting, we have hundreds of clients who pay us to find promising men for many, many supervisory and management positions. Our client list represents more first-name employment contacts than you could create in your entire lifetime. That's one of the reasons why Decision — and only Decision — can give you such broad national coverage of engineering opportunities.

Find out how Decision, originators of the unique DECISION/REGISTER, can help you make the most of your real potential. You can't lose. *Mail this coupon right now!*

DECISION/INC

*Publishers of the authoritative
Engineers' Job Directory*

Oliver P. Bardes, President
DECISION/INC
Management Consultants
1676 First National Bank Building
Cincinnati 2, Ohio



Let's get started. Show me the next step.

NAME _____

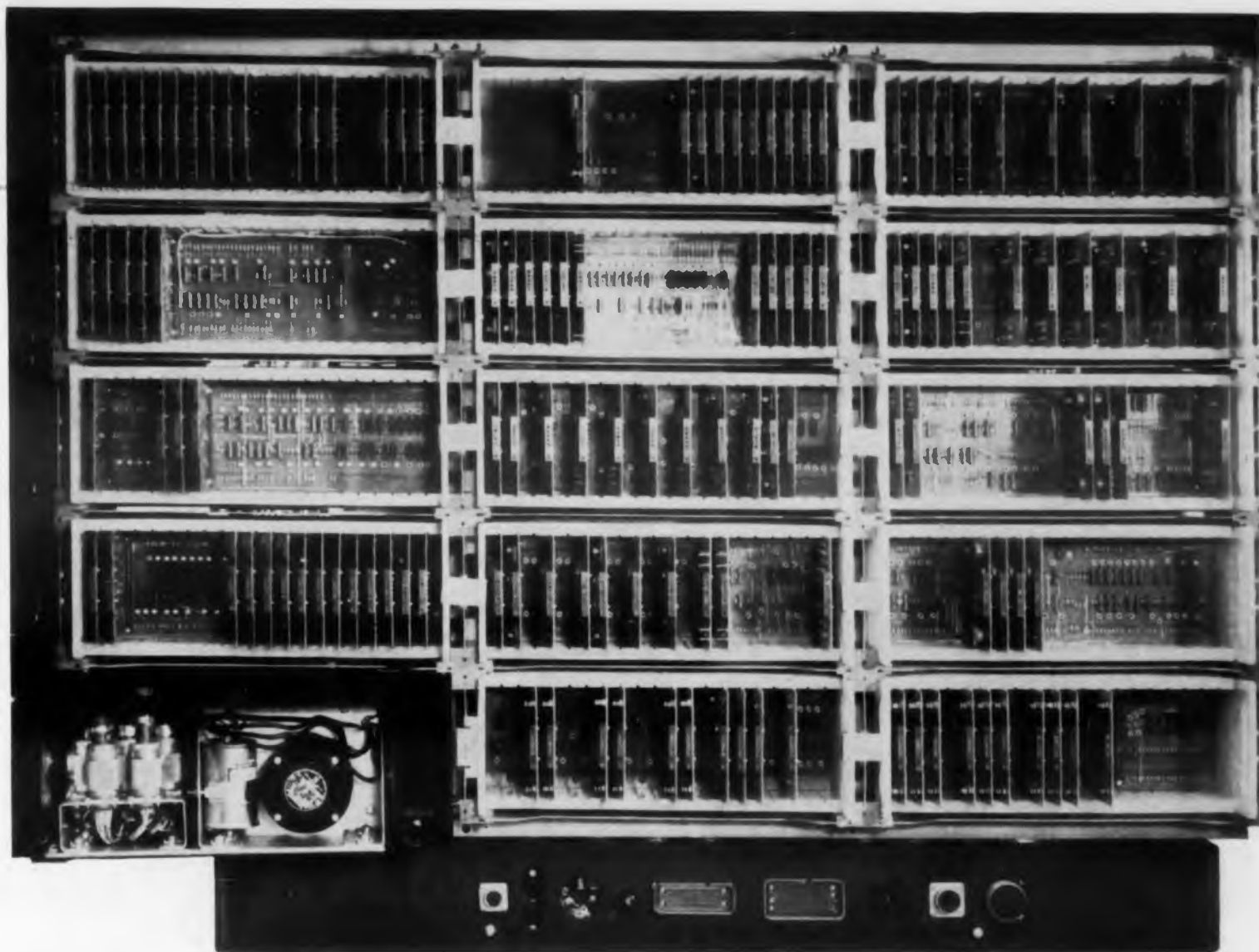
TITLE _____

ADDRESS _____

CITY _____

STATE _____

CIRCLE 552 ON READER-SERVICE CARD



The Role of PRODUCT ENGINEERING in Systems Work

It has become characteristic of modern weapons systems that they are required to operate under severe environmental conditions, as well as to meet stringent weight and space limitations. Moreover, the complexity of many of these systems poses additional difficult reliability problems, while at the same time the increasingly critical consequences that depend on the proper functioning of the typical system logically call for a *higher* degree of reliability than previously achieved. The same is true of certain electronic systems for industrial applications, such as the Ramo-Wooldridge digital control computer, some of whose design features are shown above.

Meeting all of these requirements is in large part the responsibility of product engineering. Generally speak-

ing, product engineering starts with a system or subsystem at the breadboard stage and transforms it into the final product, which in addition to meeting all of the requirements previously stated, must be practical to manufacture and to maintain. Such creative productizing requires the development of ingenious mechanical design features, a thorough knowledge of circuit design and component reliability, and a broad familiarity with materials and manufacturing processes.

At Ramo-Wooldridge, the product engineer is an essential member of the research and development team which has the full responsibility for creating new systems, from the initial theoretical studies on into the manufacturing stage. Engineers experienced in product engineering are invited to explore the variety of openings which exist at Ramo-Wooldridge in such fields as airborne electronic and control systems, communications and navigation systems, digital computers and control systems, and electronic instrumentation and test equipment.

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

CIRCLE 553 ON READER-SERVICE CARD

HI-FI CIRCUIT DESIGNER

To design underwater acoustics apparatus. Minimum 5 years design experience required.

Terrific opportunity for man who wants to develop professionally instead of administratively

Write E. A. Gentry; or call
ULster 1-5500 (Cleveland) collect

CLEVITE ORDNANCE
DIVISION OF CLEVITE CORPORATION
540 East 105th Street, Cleveland 8, Ohio

CIRCLE 554 ON READER-SERVICE CARD

HIGH LEVEL SPECIALIST

COMPONENTS ENGINEER, EE

FOR: Major company in avionics field. **AREA:** Airborne Electronic Equipment. **RESPONSIBILITY:** Design and development as well as reliability and testing of components—capacitors, gyros, resistors, transistors and others. This specialist has final authority to decide whether or not specific components shall be used in one of our products. **EXPERIENCE:** Broad working background in electronic components or systems. **STARTING SALARY: \$10,000**

WRITE TO: Box ED-11 in strict confidence.
19 E. 62nd St., New York 21, N. Y.

TELL YOUR PERSONNEL MANAGER ABOUT ELECTRONIC DESIGN'S "CAREER'S SECTION"

If your company is trying to attract skilled electronic design, development or research engineers, tell your Personnel Manager about ELECTRONIC DESIGN. Here is a concentrated audience of 25,000 engineers ready to read about the advantages offered by your plant.

Remember, more than 5,500 ELECTRONIC DESIGN readers inquire every issue—many of them will be interested in your job opportunities.

You can reach them in ELECTRONIC DESIGN'S "Career's Section."

ADVERTISING INDEX
November 15, 1957

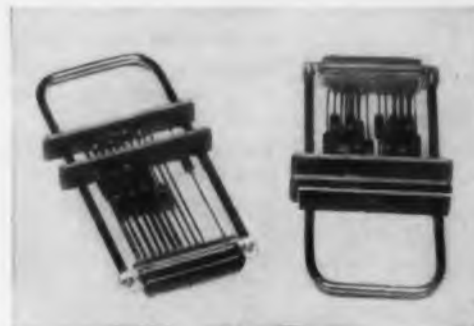
Advertiser	Page
AMP, Inc.	42
Acc Electronics Associates	163
Acme Electric Corp.	72
Acro Div., Robertshaw Fulton Controls	110
Advance Vacuum Products Co.	178
Aerotest Laboratories	180
Alden Products Co.	201
Allen Mfg. Co.	47
Allen-Bradley Co.	22
Allied Radio Corp.	200
American Rectifier Corp.	204
Amperex Electronics Corp.	17
Anaconda Wire & Cable Co.	116, 117
Applied Science Corp. of Princeton ASCOP	112
Arnold Engineering Co.	89
Arnold Magnetics Co.	183
Associated Spring Corp.	182
Automatic Metal Products Corp.	152
Belden Mfg. Co.	83
Bendix Aviation Corp., Red Bank Div.	50, 113
Berkeley Div., Beckman Instruments Inc.	127
Birtcher Corp.	185
Biley Electric Corp.	188
Borden Co., Resinite Dept., The	175
Brevel Products Corp.	188
Brew, Richard D. & Co., Inc.	159
Bulova Watch Co., Electronics Div.	151
Buggie, H. H., Inc.	85
Burndy Corp.	23
Camloc Fastener Corp.	189
Cannon Electric Co.	105
Cardinal Instrumentation Corp.	184
Celco Constantine Engineering Laboratories	134
Centralab Div. of Globe Union, Inc.	164
Chassis-Trak Corp.	132
Chicago Aerial Industries, Inc.	129
Clarostat Mfg. Co.	35
Clary Corp.	158
Clevite Ordnance	206
Clevite Transistor Products	29
Clifton Precision Products Co., Inc.	6
Comar Electric Co.	182
Computer-Measurements Corp.	165
Consolidated Mining & Smelting Co.	199
Corning Glass Works	126
Crucible Steel Company of America	11
Dage Electric Co.	179
Dale Products, Inc.	36
Daven Co., The	137
Decision, Inc.	207
De Jur Amsco Corp.	168
Delco Radio Div. of General Motors Corp.	172
Deutsch Co., The	205
Dimco-Gray Co.	157
Dit-Mco, Inc.	175
Donner Scientific Co.	191
Dorsett Laboratory	135
Drake Mfg. Co.	181
Allen B. DuMont Laboratories, Inc.	38
Du Pont, E. I. de Nemours Co., Pigment Div.	169
Eastman Kodak Co.	182
Ecor, Inc.	128
Elastic Stop Nut Corp.	200
Electro Measurements, Inc.	162
Electro-Mec Laboratory, Inc.	53
Electro-Pulse, Inc.	174
Electronic Measurements Co.	162
Electronic Resistor Corp.	180
Fairchild Controls Corp.	94
Fansteel Metallurgical Corp.	132, 133
Farr Co.	205
Fenwal, Inc.	183
Ferrocube Corp. of America	97
Film Capacitors, Inc.	133
Ford Instrument Co., Inc.	148
Formica Corp.	51
Gammwell Co.	181
Gebar Mfg. Co.	204



AN NCR ELECTRONIC ENGINEER checks the wave form of a transistorized magnetic core array tester.



TRANSISTOR printed circuit for digital computer development program.



MAGNETIC character recognition matrix for check sorters.



MECHANISMS for intricate in-put, out-put devices.

ENGINEERING UNLIMITED

AT ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

LOGICAL DESIGN, CORE AND TRANSISTOR CIRCUITRY—DIGITAL COMPUTER DEVELOPMENT—New projects in core memories and advanced core logic, magnetic and transistor circuitry—these and other advanced NCR computer efforts promise wide latitudes of technical advancement. Interesting new positions are open in these fields at NCR in Dayton for qualified engineers at senior, intermediate and associate levels.

ACT AT ONCE! Send résumé! Employment Department, Technical Procurement Section K, The National Cash Register Company, Dayton 9, Ohio.



CIRCLE 556 ON READER-SERVICE CARD

Advertiser	Page
General Ceramics Corp.	193
General Chemical Div. Allied Chemical & Dye Corp.	71
General Components, Inc.	188
General Control Co.	188
General Controls	185
General Electric Co., Apparatus Div.	123, 144
General Electric Co., Industry Control Dept.	119
General Electric Co., Electronics Equipment Div.	58, 59, 130
General Electric Co., Electronics Components	14, 15
General Motors Corp., New Departure Div.	12
General Radio Co.	182
General Transistor Corp.	171
Globe Industries, Inc.	45
Good-All Electric Mfg. Co.	25
Gries Reproducer Corp.	202
Guardian Electric	107
Gudebrod Bros. Silk Co., Inc.	144
Gulton Industries	147
H & H Machine Co.	180
Hassell, John, Inc.	205
Hayden, A. W. Co., Inc.	185
Heli-Coil Corp.	18, 19
Helipot Corp., Div. Beckman Instruments, Inc.	135
Heminway & Bartlett Mfg. Co.	181
Hewlett-Packard Co.	210, 211
Hi Temp Wires, Inc.	37
Hoffman Engineering Corp.	203
Hughes Aircraft Co.	7
Hull-Standard Corp.	145
Hycon Eastern, Inc.	86
Industrial Test Equipment Co.	200
Instrument Specialties Co.	142
Instruments For Industry, Inc.	188
International Electronic Research Corp.	92
International Resistance Co.	2
JFD, Mfg. Co.	115
Johnson, E. F. Co.	150
Joy Mfg. Co.	67
Kahle Engineering Co.	13
Kay Electric Co.	187
Kearfott Co., Inc. Little Falls Div.	173
Keithley Instrument Co.	152
Kester Solder Co.	179
Kinney Mfg. Div. New York Air Brake Co.	153
Kin Tel	24
Koiled Kords, Inc.	179
Koontz-Wagner Electric Co.	183
Kulka Electric Mfg. Co.	198
Landis & Gyr, Inc.	202
Leach Corp.	69
Librascope, Inc.	146
Magnetic Metals Co.	63
Magnetics, Inc.	87
Mallory, P. R. & Co.	128
Mansol Ceramics	204
Marconi Instrument Co.	156
Mica Insulator Co.	59
Microtran Co.	141
Milgray Electronics, Inc.	106
Miller Dial & Name Plate	178
Millivac Instrument Corp.	161
Miniature Precision Bearings	203
Minneapolis-Honeywell Regulator Co., Industrial Div.	195
Minneapolis-Honeywell Regulator Co., Transistor Div.	167
Minnesota Mining & Mfg. Co., Chemical Products Div.	177
Model Engineering & Mfg. Co.	199
Motorola, Inc.	206
Motson, J. Frank Co.	8, 9
Mullard Ltd.	21
Mycalex Corp. of America	140
Narda Corp., The	125
National Cash Register Co.	209
National Vulcanized Fibre Co.	194
Navigation Computer Corp.	201
New Hampshire Ball Bearings, Inc.	88
New York Air Brake Co.	153
Norden-Ketay Co.	160

Everything
you need!

SPECIFICATIONS

130A

Input Amplifiers: (Similar Vert. and Horiz. Amps.). Sensitivity 1 mv/cm to 50 v/cm; 14 calibrated ranges, 1-2-5-10 sequence plus continuous vernier. Pass band dc to 300 KC; ac or dc coupling. Balanced input on 1, 2, 5, 10 and 20 mv/cm ranges.

Sweep Range: 1 μ sec/cm to 12 sec/cm. 21 sweeps: 1-2-5-10 sequence, 5% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to -30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Amplitude Calibration: 1 KC square wave, 5% accuracy.

Price: \$650.00.

SPECIFICATIONS

150A, 150AR

Sweep Range: 0.02 μ sec/cm to 15 sec/cm.

Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μ sec/cm to 5 sec/cm. 3% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to -30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Horizontal Amplifier: Sweep magnification 5, 10, 50, 100 times. Vernier position control selects any 10 cm part of sweep. External input pass band dc to over 500 KC. Sensitivity 200 mv/cm to 15 v/cm.

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μ sec. Signal delay of 0.25 μ sec permits leading edge of triggering signal to be viewed.

Amplitude Calibration: 18 calib. voltages, 1-2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μ sec.

Prices: -hp- 150A High Frequency Oscilloscope, \$1,100.00.

-hp- 150AR Rack Mount Oscilloscope, \$1,200.

-hp- 151A High Gain Amplifier, \$200.00.

-hp- 152A Dual Channel Amplifier, \$250.00.

HEWLETT-PACKARD COMPANY

4407K Page Mill Road • Palo Alto, Calif., U.S.A.

CABLE "HEWPACK" • DAvenport 5-4451

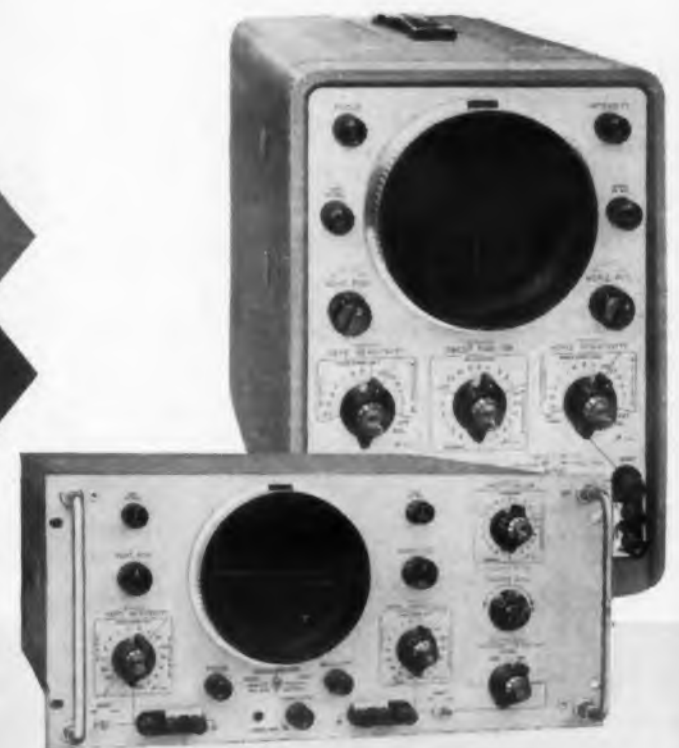
Field engineers in all principal areas

Data subject to change without notice.

Prices f.o.b. factory.

fast, easy

- Immediate delivery. See your -hp- rep now
- Direct reading, extreme accuracy
- Color-coded controls; simplest to use
- Highest performance, highest quality
- Universal automatic triggering



Low Frequency Cabinet Oscilloscope, Model 130A. Covers dc to 300 KC. Similar horizontal and vertical amplifiers. Input circuits balanced on 5 most sensitive ranges. Single ended input may be dc or ac coupled. Direct reading, linear sweep times. With most transducers, needs no preamplification to produce brilliant, high resolution trace. Universal automatic triggering; one preset condition provides optimum triggering for almost all inputs. \$650.00.

Low Frequency Rack Mount Oscilloscope, Model 130BR. Similar to -hp- 130A except for rack mount and includes x5 magnifier usable on all ranges and expanding fastest sweep to 0.2 μ sec/cm. Parallel input terminals front and rear. \$650.00.

CIRCLE 423 ON READER-SERVICE CARD

to use, quality

OSCILLOSCOPES



High Frequency Cabinet Oscilloscope, Model 150A. Covers dc to 10 MC with new reliability and convenience. Two plug-in preamplifiers for high gain or dual channel measurement (see below). 24 direct-reading sweep times; sweeps 0.02 μ sec/cm to 15 sec/cm. Universal automatic triggering; one preset condition insures optimum triggering. \$1,100.00.

High Frequency Rack Mount Oscilloscope, Model 150AR. Same as -hp- 150A except for mounting in standard relay rack. Fitted with "pull-out" slides for maximum servicing accessibility. \$1,200.00.



High Gain Amplifier, Model 151A. Designed for plug-in use with -hp- 150A or 150AR Oscilloscopes. High gain unit with 5.0 mv per cm sensitivity and frequency response dc to 10 MC. 12 calibrated ranges in 0.5, 1, 2, 5 sequence. 1 megohm input impedance with 25 μ f shunt. Pass band rise time 0.035 μ sec. Equipped with two BNC input terminals. \$200.00.



Dual Channel Amplifier, Model 152A. Designed for plug-in use with -hp- 150A or 150AR Oscilloscopes. Permits two phenomena to be presented on CRT simultaneously. Either amplifier usable separately. For dual presentation, electronic switch applies outputs to alternate traces, or switches outputs at a 100 KC rate. 50 mv/cm sensitivity, 9 ranges, 1, 2, 5, 10 sequence. \$250.00.

CIRCLE 423 ON READER-SERVICE CARD

Advertiser	Page
Oak Mfg. Co.	34
Ohmite Mfg. Co.	143
Oster, John Mfg. Co.	120
Pacific Scientific Co.	154
Phaotron Co.	152
Phelps-Dodge Copper Products Co.	28
Phillips Control Corp.	187
Polorad Electronic Corp.	10, 11
Polytechnic Research & Development Co.	109
Potter Instrument Co.	3
Pyle-National Co., The	49
Radio Condensor Co.	93
Radio Corp. of America	212
Ramo-Wooldridge Corp.	207
Raytheon Mfg. Co., Equipment Market Div.	73, 75, 77, 79, 81
Raytheon Mfg. Co., Microwave & Power Tube	10
Raytheon Mfg. Co., Personnel	155, 156, 157
Raytheon Mfg. Co., Semi-Conductor Div.	4
Reeves-Hoffman Div.	162
Rex Corp., The	74
Richards Electrocraft, Inc.	155
Rider, John F. Publisher, Inc.	180
Roebblings Sons, John A., Inc.	22A
Safeway Heat Elements, Inc.	40
Sage Electronics Corp.	162
Sanborn Co.	39
Sanders Associates, Inc.	121
Sangamo Electric Co.	23A
Sarkes-Tarzian, Inc.	148
Servo Corp. of America	142
Shalleross Mfg. Co.	166
Shell Chemical Corp.	111
Simpson Electric Co.	26, 27
Smith, Herman H., Inc.	200
Sola Electric Co.	201
Sorensen & Co., Inc.	16
Southern Screw Co.	147
Speer Carbon Co.	101
Sprague Electric Co.	33
Stackpole Carbon Co., Jobbing Div.	103
Standard Instrument Corp.	203
Standard Pressed Steel Co.	181
Star Stainless Screw Co.	198
Statham Laboratories, Inc.	147
Steafix	187
Stevens Mfg. Co.	131
P. A. Sturtevant Co.	183
Superior Tube Co.	202
Sylvania Electric Products, Parts Div.	170
Sylvania Electric Products, Tungsten Div.	124
Sylvania Electric Products, Waltham & Mountain View	206
Technic, Inc.	134
Technitrol Engineering Co.	154
Technology Instrument Corp.	150
Texas Instruments, Inc.	106, 107
Thermosen, Inc.	158
Thomas & Skinner Steel Products	146
Transco Products	145
Transistor Devices, Inc.	153
Transitron Electronic Corp.	118
Trio Laboratories, Inc.	189
Tri-Point Mfg. Co.	205
Tung-Sol Electric Co.	43
Unimax Switch Div.	82
Union Switch & Signal Div.	122
United Electronics Corp.	136
U. S. Semi-Conductor Products	149
Unitek Corp.	163
Varflex Corp.	203
Varian Associates	20
Waters Mfg. Co.	156
Weckesser Co.	178
West Coast Electrical Mfg. Co.	186
Western Devices, Inc.	129
Westinghouse Electric Corp., Industrial Tube Div.	139
Weston Electrical Instrument Co.	61
Wincharger Corp.	41
Zero Mfg. Co.	184



A new
measure of
performance



miniature RCA-6973...for your compact high-fidelity designs

To help you endow your popular-priced high-fidelity amplifier designs with a noteworthy measure of concert-hall presence, RCA proudly presents its latest audio-tube development—the RCA-6973. Featuring linear operation over a wide range of power, a pair of these beam-power, 9-pin miniatures can deliver 20 watts of audio power with only 1.5% distortion. Here, too, is a tube that offers the advantages of low heater wattage (6.3v at only 450 ma)!

And, for a new measure of performance in medium-priced high-fidelity FM receivers, RCA presents two new tubes—the 6DT8 and the 12DT8. These new RF amplifier and mixer-oscillator tube types can make valuable contributions to your FM-tuner designs. Both types have inter-unit shielding enabling you to achieve substantial reductions in antenna radiation.

For data sheets on any of these new types, or for information on other well-known RCA "audio" tubes, such as the 12AX7 and 6L6-GB, write to RCA Commercial Engineering, Section K-18-Q-2, Harrison, N.J.

Your RCA representative is ready to discuss your high-fidelity tube requirements. Why not call him today at the field office nearest you?



TUBES for HIGH FIDELITY

RADIO CORPORATION OF AMERICA
Electron Tube Division Harrison, N.J.

RCA District Offices:

East:
744 Broad Street, Newark, N. J.
HUMboldt 5-3900

Midwest:
Suite 1181, Merchandise Mart Plaza
Chicago, Ill.
WHitehall 4-2900

West:
6355 E. Washington Blvd.
Los Angeles, Calif.
RAYmond 3-8361

◀ CIRCLE 470 ON READER-SERVICE CARD

HAYDEN PUBLISHING COMPANY, INC.
19 East 62nd Street, New York 21, N. Y.

LEADER DESIGN