

# ELECTRONIC DESIGN

AUGUST 17, 1960

AUG 23 1960

A Critical Comparison of Russian and American Test Equipment with Comments by Industry Leaders



**GIVE YOUR PRODUCTS**

**MORE RELIABILITY AND BETTER PERFORMANCE WITH**

**-FREED QUALITY**

**MINIATURE AUDIO TRANSFORMERS to MIL Specifications**



- Hermetically sealed Grade 4.
- Frequency response:
  - ± 2DB 30-20,000 CPS
  - ± 2DB 200-10,000 CPS

Cat. No.	Imped. level —	Appl.	MIL Type
PMA 1	Pri. 50/200/500 Sec. 60,000 C.T.	Line or mho to single or P.P. grids	TF4RX10VY
PMA 2	Pri. 4/8 Sec. 60,000 C.T.	Dynamic mho or mho. voice coil to single or P.P. grids	TF4RX10VY
PMA 3	Pri. 50/200/500 Sec. 60,000 C.T.	Line or mho to single or P.P. grids	TF4RX10VY
PMA 4	Pri. 15,000 Sec. 60,000 C.T.	Single triode plate to single or P.P. grids	TF4RX15VY
PMA 5	Pri. 15,000 Sec. 60,000 C.T.	Single triode plate to P.P. grids	TF4RX15VY
PMA 6	Pri. 15,000 Sec. 50/200/500	Single triode plate to multiple line	TF4RX15VY
PMA 7	Pri. 15,000 Sec. 50/200/500	Single triode plate to multiple line	TF4RX15VY
PMA 8	Pri. 30,000 C.T. Sec. 50/200/500	Push-pull triode plate to multiple line	TF4RX15VY
PMA 9	Pri. 60,000 C.T. Sec. 50/200/500	Crystal mho or pickup to multiple line	TF4RX15VY
PMA 10	Pri. 50/200 Sec. 50/200/500	Mixing or matching	TF4RX16VY
PMA 11	40 by 3 mm. d.s. 3500 Ω d.c. res.	Parallel load reactor	TF4RX20VY

**Ruggedized, MIL STANDARD POWER & FILAMENT TRANSFORMERS**

Primary 105/115/125 V 50-60~

Cat. No.	Appl.	MIL Std.	MIL Type
MGP 1	Plate & Fil.	90026	TF4RX03HA001
MGP 2	Plate & Fil.	90027	TF4RX03JB002
MGP 3	Plate & Fil.	90028	TF4RX03KB006
MGP 4	Plate & Fil.	90029	TF4RX03LB003
MGP 5	Plate & Fil.	90030	TF4RX03MB004
MGP 6	Plate	90031	TF4RX02KB001
MGP 7	Plate	90032	TF4RX02LB002
MGP 8	Plate	90036	TF4RX02NB003
MGF 1	Filament	90016	TF4RX01EB002
MGF 2	Filament	90017	TF4RX01GB003
MGF 3	Filament	90018	TF4RX01FB004
MGF 4	Filament	90019	TF4RX01HB005
MGF 5	Filament	90020	TF4RX01FB006
MGF 6	Filament	90021	TF4RX01GB007
MGF 7	Filament	90022	TF4RX01JB008
MGF 8	Filament	90023	TF4RX01KB009
MGF 9	Filament	90024	TF4RX01JB012
MGF 10	Filament	90025	TF4RX01KB013

**HERMETICALLY SEALED, MIL-T-27A PULSE TRANSFORMERS**

- Maximum power efficiency and optimum pulse performance.
- For use in blocking oscillator, interstage coupling and low level output circuits.
- Ruggedized construction — Grade 4.
- Series or parallel connection of windings for optimum turns ratio.



Cat. No.	MIL Type	Pulse Voltage Kilovolts	Char. Imp. Ohms
MPT-1	TF4RX35YY	0.25/0.25/0.25	250
MPT-2	TF4RX35YY	0.25/0.25	250
MPT-3	TF4RX35YY	0.5/0.5/0.5	250
MPT-4	TF4RX35YY	0.5/0.5	250
MPT-5	TF4RX35YY	0.5/0.5/0.5	500
MPT-6	TF4RX35YY	0.5/0.5	500
MPT-7	TF4RX35YY	0.7/0.7/0.7	200
MPT-8	TF4RX35YY	0.7/0.7	200
MPT-9	TF4RX35YY	1.0/1.0/1.0	200
MPT-10	TF4RX35YY	1.0/1.0	200
MPT-11	TF4RX35YY	1.0/1.0/1.0	500
MPT-12	TF4RX35YY	0.15/0.15/0.3/0.3	700

**Ruggedized, MIL STANDARD AUDIO TRANSFORMERS**

Cat. No.	Imped. level—ohms	Appl.	MIL Std.	MIL Type
MGA 1	Pri. 10,000 C.T. Sec. 90,000 Split & C.T.	Interstage	90000	TF4RX15AJ001
MGA 2	Pri. 600 Split Sec. 4, 8, 16	Matching	90001	TF4RX16AJ002
MGA 3	Pri. 600 Split Sec. 125,000 C.T.	Input	90002	TF4RX10AJ001
MGA 4	Pri. 600 Split Sec. 600 Split	Matching	90003	TF4RX16AJ001
MGA 5	Pri. 7,600 Tap @ 4,800 Sec. 600 Split	Output	90004	TF4RX12AJ001
MGA 6	Pri. 7,600 Tap @ 4,800 Sec. 4, 8, 16	Output	90005	TF4RX13AJ002
MGA 7	Pri. 15,000 C.T. Sec. 600 Split	Output	90006	TF4RX12AJ003
MGA 8	Pri. 24,000 C.T. Sec. 600 Split	Output	90007	TF4RX13AJ004
MGA 9	Pri. 60,000 C.T. Sec. 600 Split	Output	90008	TF4RX13AJ005

**CONSTANT VOLTAGE TRANSFORMERS.**

- Meets Military Specifications
- No Tubes
- No Moving Parts
- Accurate Regulations
- Fast Response
- Fully Automatic



Here at last is a hermetically sealed magnetic voltage regulator that will provide constant output voltage regardless of line and/or load changes.

SUPPLIED EITHER MIL OR COMMERCIAL				
CAT. #	INPUT VOLT.	LINE FREQ.	OUTPUT VOLT. VA.	OUTPUT VA.
MCV-620L	95-130 v	60 cps.	115	20
MCV-670L	95-130 v	60 cps.	115	70
MCV-6130L	95-130 v	60 cps.	115	130
MCV-670F	95-130 v	60 cps.	6.4	70
MCV-6130F	95-130 v	60 cps.	6.4	130
MCV-420F	95-130 v	400 cps.	6.4	20

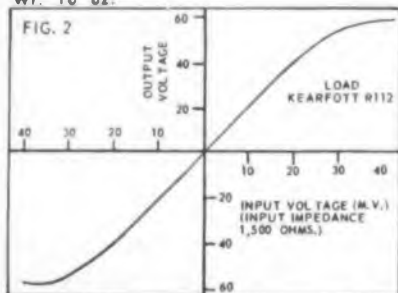
**MAGNETIC AMPLIFIERS**

- Hermetically Sealed To MIL Specifications
- No Tubes
- Direct Operation from Line Voltage
- Fast Response
- Long Life Trouble Free Operation
- Phase Reversible Output

Power Gain 2 x 10<sup>6</sup>



Transistor Preamp. MAT-1 Wt. 10 oz.  
Mag. Amp. MAF-5 Wt. 18 oz.  
Motor



**FREED QUALITY INSTRUMENTS FOR PRECISION LABORATORY TESTING**

**NO. 1110-AB INCREMENTAL INDUCTANCE BRIDGE**



- Inductance: 1 Millihenry to 1000 Henry
- Maximum Direct Current: 1 Ampere

**NO. 1620 VARIABLE TEST VOLTAGE MEGOHMMETER**



- Variable DC test voltage: 50 to 1000 volts
- Resistance range: .1 megohm to 4,000,000 megohms

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**FREED TRANSFORMER CO., INC.**

1727 Weirfield Street Brooklyn (Ridgewood) 27, New York

**ELECTRONIC DESIGN**



COVER: The old-fashioned scales shown are symbolic of a long-standing problem—how to compare U.S. and Soviet electronic equipment. The Russian Trade Fair in New York last year gave *ELECTRONIC DESIGN*'s editors enough to start the comparison. Through detailed examination, lasting over a period of many months, the editors have been able to produce a full-dress, side-by-side staff report on how the two countries stack up. The report begins on p 50. Cover engraving is furnished by The Bettman Archive.

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◀ CIRCLE 1 ON READER-SERVICE CARD

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607	617	627	637	647	657	667	677	687	697
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609	619	629	639	649	659	669	679	689	699

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9	19	29	39	49	59	69	79	89	99

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605	615	625	635	645	655	665	675	685	695
606	616	626	636	646	656	666	676	686	696
607	617	627	637	647	657	667	677	687	697
608	618	628	638	648	658	668	678	688	698
609	619	629	639	649	659	669	679	689	699

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## New York to Philadelphia to Moscow

Like most of *ELECTRONIC DESIGN's* staff reports, this issue's critical comparison of Russian and U.S. test equipment beginning on p 50 has been long months in the making.

It started last fall, when Associate Editor George Rostky heard a paper by Bruno Weinschel, president of Weinschel Engineering and chairman of the Washington chapter of the IRE Professional Group on Instrumentation, read at a meeting in Philadelphia. Rostky's curiosity was piqued and he obtained permission to publish the findings.

Armed with photos and descriptions of 30 instruments shown at the Russian Exhibition in New York a year ago, Rostky approached leading U.S. manufacturers and asked them to supply pictures and descriptions of similar instruments made in the U.S.

Rostky also interviewed former IRE president Donald Sinclair and obtained comments from David Packard of Hewlett-Packard on their observations of Russian test equipment, based on the two men's recent trips to the Soviet Union.

To top off this report, *ELECTRONIC DESIGN* commissioned Soviet engineer Anatoli V. Gorokhovskiy to appraise his own country's equipment. His comments begin on p 70.

### Focus on Communications

Now, and for several months to come, communications will be increasingly in the spotlight. In this issue, *ELECTRONIC DESIGN* carries a report on the National Symposium on Global Communications (GLOBCOM) as well as a report on underground communications. Both of these start on p 4. In the months to come, we will carry special coverage of the Sixth National Communications Symposium at Utica, N.Y., and will continue our coverage of frequency allocation, satellite communications, and various other facets of this field.

### WESCON, Aug 23-26

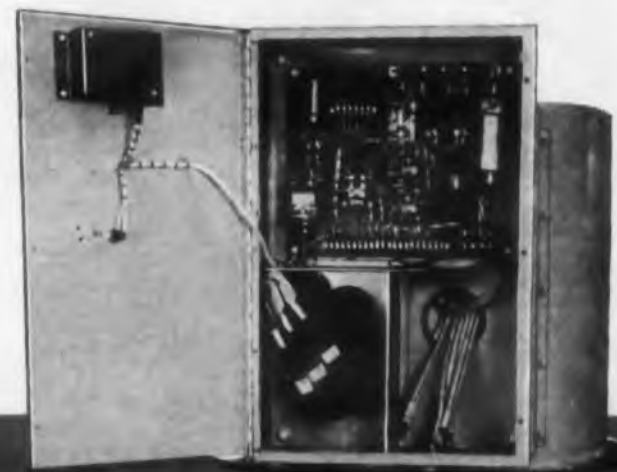
We're looking forward to seeing as many of our friends as can come to the *ELECTRONIC DESIGN* Booth 2714-5 at WESCON. Drop by and say hello, bring us editorial ideas, and any complaints and suggestions you might have. Let's get better acquainted.

CIRCLE 2 ON READER-SERVICE CARD

## At Bogue Electric Mfg. Co....

AUG 23 1960

# where stability is vital



## RED / LINE

Timing relays guard against extreme heat



In the high cycle motor generators produced by the Bogue Electric Mfg. Co., the stability of the thermal relay is a vital operating factor. That is why Bogue design engineers selected G-V Red/Line Thermal Timing Relays over all others to delay the operation of the water pressure protective circuit while water pressure is built up in the cooling coils during starting of the motor generator. The Timing Relay then inserts the protective circuit and thus dangerous extremes of heat are avoided, insuring the efficient performance of the generators. So, at Bogue the high quality of G-V Timing Relays is "paying off".

More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will "pay off" in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

Your G-V distributor has them in stock now. Call him or write for Bulletin 131 today.



G-V CONTROLS INC.  
Livingston, New Jersey

G-V



# UPGRADE YOUR CIRCUIT

with Weldmatic Welding

Take the big step to reliability through the miracle of electronic welding. Your component packaging can benefit from the five proven advantages:

SIZE AND WEIGHT REDUCTION  
INCREASED RELIABILITY  
GREATER STRENGTH  
EXACT REPEATABILITY  
LOWER PRODUCTION COSTS



Solder Joint

Weldmatic Joint

The reason is revealed in the joint.

Compare these tinned copper-wire resistor leads, welded and soldered, each magnified 50 times. In the solder joint, resistance is created through plating on the surface and through the addition of solder. Note the poor connection. In the Weldmatic welded joint, you can see complete fusion of the parent metals. This welded joint is stronger than the parent metals, has excellent conductivity, and can be produced without operator skill.

Ask Weldmatic for a free sample weld evaluation... you'll receive the best in current technical knowledge.

WELDMATIC DIVISION  
950 Royal Oaks Dr., Monrovia, Calif.

# UNITEK

CIRCLE 3 ON READER-SERVICE CARD

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## Coming Next Issue

By and large, electronic design engineers have neglected what can be one of their most potent tools—the digital computer. To help overcome this deficiency, *ELECTRONIC DESIGN* will present a roundup of digital computer applications by electronics designers.

This will differ from the usual treatment in the literature wherein a specific application is treated in depth. Instead, by showing dozens of applications in breadth, the report should stimulate even those engineers who don't find their problems listed to think about —Designing with Digital Computers.



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## OFF THE SHELF DELIVERY

delivered  
in 24 hours



### SILICON RECTIFIER Power Supply



Circuitry Primary 105/115/125 Volts\*\*  
Hermetic sealed to MIL-T-27A  
See Catalog for additional information.

Part Number	Secondary A.C. Volts	R.M.S. Amperes	Rectifier Circuit Full Wave	C.T.**	F.W.** Bridge
M8018*	18.5 C.T.	1	7V.	14V.	
M8019*	18.5 C.T.	3	7	14	
M8020*	35 C.T.	3	14.5	29	
M8021*	70 C.T.	1	30	60	
M8022†	18.5 C.T.	3	7	14	
M8023†	35 C.T.	3	14.5	29	
M8024†	70 C.T.	1	30	60	

\*380-1600 Cy. \*\*DC output volts stated are for resistive or inductive loads. Capacitor input may be used if RMS AMPS is not exceeded.

### ULTRA MINIATURE TRANSISTOR



Open-frame (-F)\* Wt. .08 oz. size 3/8" x 3/8" x 11/32"  
Molded (-M)\* Wt. .14 oz. size 1/2" x 1/2" dia.  
Nylon Bobbin, Nickel-Alloy

Part Number	Application	Primary Impedance (Ω)	Secondary Impedance
UM 21*	Input	1,000	1,000
UM 22*	Input	1,000	1,000
UM 23*	Driver	20,000	1,200 C.T.
UM 24*	Output	1,000	50
UM 25*	Output	400	50
UM 26*	Output	400	11
UM 27*	Output	400 C.T.	11
UM 28*	Choke	10 Hy. (0 dc) 8 Hy. (1.5 ma)	650

\*Add either -F or -M to designate construction. See catalog.

### MINIATURE TRANSISTOR



Available in 8 case types.  
Hermetic(-H) 15/16" x 1 1/8", Wt. 1 3/4 oz.  
Molded (-M) 3/8" x 3/8" x 1 15/32", Wt. 1 3/4 oz.  
Open Frame(-F) 3/4" x 1" x 1 1/16", Wt. 1 oz.

Part Number	Application	Pri. Imp.	Sec. Imp.
MT1*	Line to Emit.	600	600
MT7*	Coll. to P.P. Emit.	25,000	1,200 C.T.
MT8*	P.P. Coll. to P.P. Emit.	25,000	1,200 C.T.
MT9*	Line to P.P. Emit.	600 C.T.	1,200 C.T.
MT11*	P.P. Coll. to P.P. Emit.	4,000 C.T.	600 C.T.
MT13*	P.P. Coll. to Speaker	4,000 C.T.	3.4
MT14*	Coll. to Speaker 2N179	400	10
MT15*	P.P. Servo Output 2N57	500 C.T.	210
MT18*	P.P. Coll. to P.P. Emit.	25,000 C.T.	1,200 C.T.
MT23*	P.P. Coll. to Servo	250 C.T.	1,000

Add either -AG, -M, -FB, -FPB, -A, or -P to Part Number to designate construction. See catalog for detailed information.

### TRANSISTOR DRIVER



Designed specifically for  
transistor, servo  
and audio

Frequency response 70-20K

Size AF mill through AH Hermetically sealed to MIL-T-27A.

EPOXY MOLDED See catalog for exact sizes and weights.

ON SPECIAL ORDER ONLY

Part Number	Application	Pri. Imp.	Sec. Imp.	Pri. D.C. Unbal. Ma.	Level Watts
M8002*	Coll. to P.P. Emit.	560	400 C.T.	18	.15
M8003*	Coll. to P.P. Emit.	625	100 C.T.	20	1.5
M8004*	Coll. to P.P. Emit.	5,400	600 C.T.	15	.075
M8005*	Coll. to P.P. Emit.	7,000	320 C.T.	7	.040
M8006*	Coll. to P.P. Emit.	10,000	6,500 C.T.	.75	.005

\*Bi-Filar wound to minimize switching transients.

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## New Underground Radio Passes Tests

*Lithocom Uses Deep Rock Layers for Transmission;  
Ranges of Several Hundred Miles Seen Feasible*

**A** NEW APPROACH to underground radio, in which signals are transmitted through deep, non-conductive rock formations, promises to speed development of blast-proof communications for hardened missile launch sites. In recent tests near Carlsbad, N.M., messages were sent 4.5 miles through a layer of dry salt 1,000 ft below the earth's surface. A conventional 60-words-per-minute Teletype channel was transmitted over this distance via a 150-kc car-

rier using approximately 200 w of rf power.

The new technique, named "Lithocom" (for communication through rock), was originated by the Developmental Engineering Corp., Leesburg, Va. Other underground radio systems being developed for possible use at Minuteman and Titan sites achieve propagation through the atmosphere rather than underground.

In such "up, over, and down" systems, radiation from an underground antenna is directed

up through the earth's surface, propagates through the atmosphere, re-enters the earth, and is received by a buried antenna. Lithocom proponents suggest that this requires comparatively high power, both to achieve propagation in the first place and to overcome atmospheric and man-made interference. Lithocom, on the other hand, is claimed to be almost completely immune to interference, since the earth above the rock formation acts as an rf shield. The only

## GlobCom Systems Choice Mired in Studies

*RFI, Spectrum-Space Problems Contribute to Delay;  
Decision Awaits Evaluations, Symposium Is Told*



"World-wide communication via satellites might prove to be a force for peace in its own right," says Dr. R. F. Mettler, executive vice president of Space Technology Laboratories at the Fourth National Symposium on Global Communications.

**P**ROBLEMS, not solutions, characterize the state of the art in global communications. This was apparent at the Fourth National Symposium on Global Communications, held two weeks ago in Washington, D.C.

Some of the difficulties—reliability, timing, and satellite utilization—are clearly the responsibility of designers. But several major problems—interference, economics, and control—will be solved only by cooperation among many groups.

Lumped together, the problems are preventing clear selection of one system or combination of systems as the long-haul communication method of the near future. This much was stated by banquet speaker Maj. Gen. E. F. Cook, deputy chief signal officer of the Army, who said, "We are at a crossroads in global communications," and are examining research efforts in the many component areas of long-haul systems to decide "which direction to take."

Satellite utilization and interference and spectral problems were prominent among the studies discussed at the symposium. Specialists in the latter area were outspoken in calling for im-

mediate action to clear the hf spectrum.

C. L. Spencer, Development Engineering Corp., told a large audience that "slum clearance" of the hf spectrum is both possible and necessary. He proposed a four-part program to:

1. Reduce the width of guard bands (which he said account for a 25 per cent loss of spectrum) by using highly accurate frequency standards and frequency synthesizers.

2. Achieve 1,000 cps of information transfer with each kilocycle of spectrum used by clearing out continuous wave from its present channels (which require 3 kc of hf band) and by reducing the present 3 to 4 kc allotted to single-channel teletype to 110 cps (which would also be able to handle cw traffic). Mr. Spencer also called for reduction of voice traffic and for a policy of transmitting only when sending information.

3. Clean up transmitters by reducing self-generated interference and minimize spurious response and of receivers; expand use of directional antennas and transmit only at power needed rather than at full transmitter power.

(continued on p 6)





**Transmitting equipment** for Lithocom underground radio was tested in mines near Carlsbad, N.M., achieved 4.5-mile range through 1,000-ft salt layer.

noise encountered during the experiments has been thermal noise of about 1 db within the equipment itself.

According to Lucien Rawls, technical director for Lithocom at Developmental Engineering Corp., transmission frequencies over a spectrum from a few kc up to perhaps 3 mc could be employed in substrata communications. Given transmitting powers of several kilowatts, communication ranges of several hundred miles are thought to be feasible. Tests to date indicate average propagation losses of about 1 db per mile.

Voice transmissions are also considered possible. In tests at the New Mexico site, vocal communication was established over a 2-mile path. Fidelity was rather poor due to the narrow bandwidth of the equipment employed, but improved gear would provide a signal of satisfactory quality.

#### Several Media Can Be Used

Both the Teletype and voice tests were conducted with equipment located in mine tunnels and employing a layer of dry salt as the propagating medium. Developmental Engineering Corp. has performed geological and technical studies to establish that substrata of the proper types can be found at most sites without extensive drilling. Dry salt, limestone, granite, and quartzite can all be used and occur frequently near the surface.

In an actual Lithocom system, a well shaft would be sunk to the propagating layer and both antenna and electronic equipment would be housed in the shaft for protection against blast. Shafts ranging from 8 in. to 2 ft in diameter can be conveniently sunk and equipment could be readily packaged to fit such dimensions. Dipole or other linear antenna configurations are suggested.

(continued on p 6)

CIRCLE 5 ON READER-SERVICE CARD >



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## NEWS

### UNDERGROUND (continued from p 5)

The New Mexico tests were conducted using magnetic loop antennas made of copper tubing and having apertures of over 100 sq ft. Dipole antennas would be more convenient and more efficient.

Equipment design for Lithocom would be straightforward. Conventional low-frequency and Teletype gear is being employed in tests. Receivers are however fitted with cascode front-end amplifiers.

Lithocom designers are now trying to establish the optimum transmission frequencies for the various propagating layers which may be used. Bandwidth at all frequencies appears adequate for the purpose intended. The 150-kc transmission tests could have accommodated up to four 60-word-per-minute Teletype channels

### GLOBCOM (continued from p 4)

4. Allocate frequencies in steps of 1 kc as done by NATO and some U.S. services. This would maintain orderliness and avoid most of the confusion now rampant in industrial communications.

L. S. F. Meaker, of the directorate of communications electronics, USAF, said in delivering a paper which evaluated the high-frequency band, that the problem with hf is not so much the assignment of frequencies, which is still troublesome, but the effects of interference. He said it is impossible to predict by analysis what the interference characteristics of a new system will be, that it is only by actual operation that the true quality of a design can be learned.

Mr. Meaker concluded that the high-frequencies are good, provided they are properly managed and shared to a maximum. He reported that the exodus of many services from the hf band has slowed and may reverse.

"Electronic Franksteins" and their use in systems was discussed by General Electric's B. H. Baldrige, who illustrated his subject by saying, "Our laboratories and factories produce receivers capable of detecting two wires rubbing together in Tibet, along with micro electronics with phenomenal parts density. Yet in the adjacent laboratory we create a monstrous mega-

instead of the one which was used. At lower frequencies and at longer distances, however, bandwidth may restrict capacity somewhat, especially if voice communication were to be a part of the system.

Developmental Engineering Corp. has been working on Lithocom since the beginning of the year and has spent about \$200,000 of company funds on the project thus far.

Other companies active in hardened communications systems have followed the "up, over, and down" approach. These include Raytheon, Boeing and Space Electronics Corp. Developmental Engineering Corp. is also active in this area and until the end of last year was working jointly with Raytheon on Minuteman launch-site communication studies.

The desirability of underground radio for missile sites is indicated by the cost of deep-buried cables which might otherwise provide blast-proof communications. Cabling costs run as high as \$20,000 per mile with several hundred miles of cables needed for a 50-missile complex. ■ ■

watt radar set that will curl up the thin-film circuitry, change all the ones to zeroes in the computer, fuse the micromodules together, burn out crystals, and saturate the sensitive detectors, rendering them useless."

He called for better system and equipment engineering to utilize the spectrum more economically. This would result in systems requiring a minimum use of the "natural resource" of spectrum.

#### Active Satellite Best in One View

One of the highlights of the symposium was the detailed report delivered by C. A. Brown of Convair (Astronautics), which showed figures said to demonstrate that from both a technological and economical standpoint, active communications satellite systems appear superior to other long-haul systems for global communications.

The satellite system his group analyzed for comparison with other communications systems would handle TV and voice at up to 100 mc with no more than an average error rate at ranges that could vary from 2 to 10,000 miles. The system would have 16 satellites costing \$4 million each and a \$24-million ground station. Life would be about two years, reliability would probably be high and security would be good. ■ ■



## TAMING OF THE SCREW

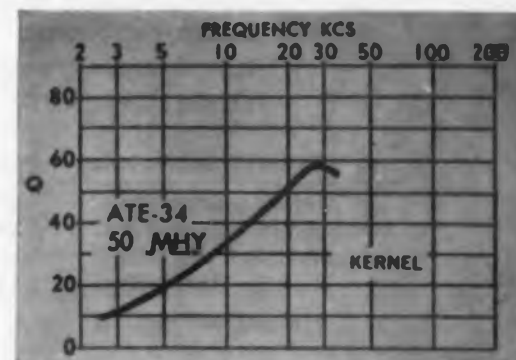
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CIRCLE 8 ON READER-SERVICE CARD

## NEWS

# NBS Building Analog-Digital Machine

### Differential Analyzer Will Combine Analog Speed and Digital Accuracy

**A** DIFFERENTIAL analyzer combining the advantages of both analog and digital computation is under construction at the National Bureau of Standards data-processing systems laboratory.

Design of an analog-digital integrator has been completed and the digital portion of the first prototype unit has been built. Work has also begun on a multiplier designed for the prototype machine, according to Walter D. Urban, electronic scientist for the laboratory.

If the analyzer proves feasible it will probably find applications in the solution of dynamic differential equations, such as those used in missile or aircraft design, where required accuracy is much greater than that provided by present analog computers. Accuracy 10 to 100 times better is expected from the hybrid analyzer.

The analog-digital differential analyzer, proposed by Dr. Harold K. Skramstad, assistant chief for

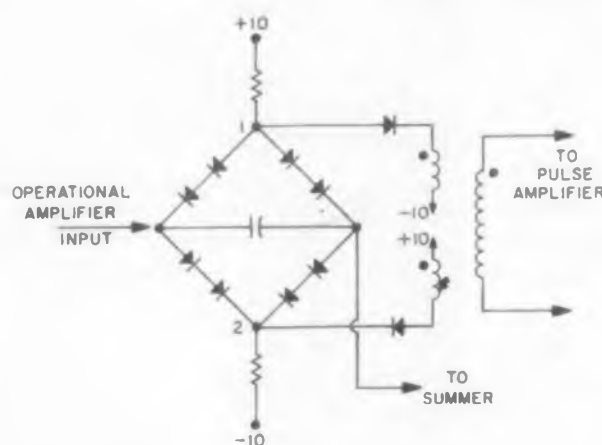
systems in the laboratory, at the Eastern Joint Computer Conference in December, 1959, represents the value of a changing variable by two quantities, one of them digital and the other analog. The more significant portion of the value is represented digitally, and the less significant portion in analog form.

#### Deficiencies Overcome

This technique combines the best features of the DDA and the analog computer, overcoming some of the deficiencies of each, according to Dr. Skramstad.

The analog computer operates at high speed and gives a continuous solution. Long term stability is a problem, however, because resistance changes and other factors during a long run reduce accuracy. The computer must be scaled so that the values of variables being represented do not fall outside of the voltage range being used. If wide dynamic range is required very large changes in the variables may be represented by small voltage variations because of this scaling requirement.

A digital differential analyzer, on the other hand, can have any accuracy required and scaling is not



**Diode bridge** transmission gate isolates integrating capacitor, which is shunted across an operational amplifier, during a clock cycle. A positive pulse from the pulse amplifier at the end of the cycle allows the capacitor to discharge into the dc sources at the top and the bottom of the diagram. One diode in each arm of the bridge is a silicon junction type with high back impedance to prevent leakage, and the other is a germanium fast recovery type.

**Graph illustrates** method of integration in the planned NBS analog-digital differential analyzer. The major portion of dependent variable,  $x$ , is represented digitally, as shown by areas  $x_{D1}, x_{D2}, \dots, x_{Dn}$ . The remainder of the variable's value is represented by either a positive or negative analog voltage, indicated by the shaded area. At the end of a clock cycle  $\Delta t$ , if the analog value shifts over a specified threshold amount, the digital value  $x$  is incremented or decremented by one unit. The total integration is provided continuously by summing areas 1 and 2 with the shaded area 3.



required. Speed is a problem and solutions are not continuous.

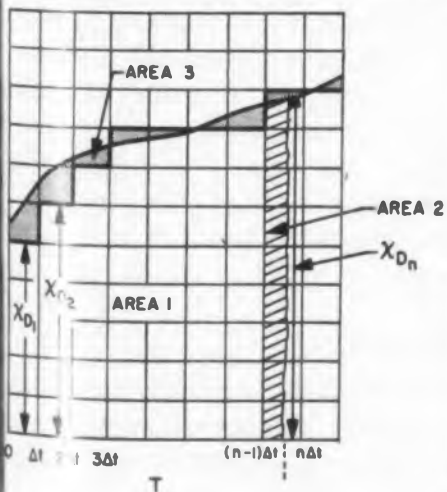
The system being built combines the speed and continuous solutions of the analog computer with the wide dynamic range and accuracy of the digital machine. Scaling is required, however, the required scaling range is much smaller than that required in fully analog computation. Scaling over a small range of values also helps overcome the stability problem because small value shifts in the analog circuits have little effect on accuracies.

#### Still Restrictions

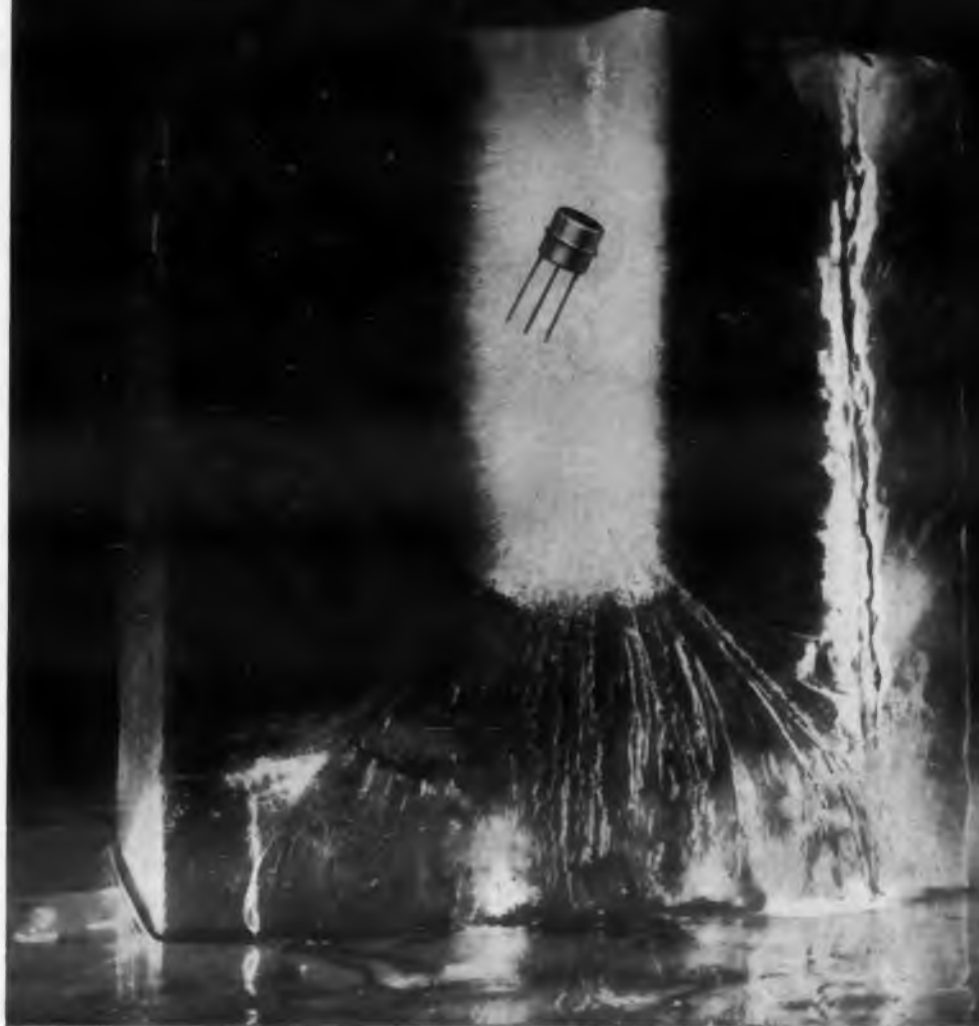
There is a restriction with this type of computation on the rapidity with which a variable can change, or on the time derivative of the variable. This can be seen by referring to the accompanying graph illustrating the computation method. If the analog voltage equivalent to a unit increment in the digital value of the variable,  $x$  in this case, is designated  $a$ , then  $dx/dt$  can not exceed  $a/\Delta t$ .

This is necessary because if the analog portion of the variable changes by a set threshold amount over the course of a clock cycle— $\Delta t$  in the graph—then the digital value is incremented, or decremented in the case of negative slope, by one unit at the end of the cycle. If the analog value begins to change too rapidly, however, even the one unit incrementing each clock cycle will not prevent the value of variable from moving outside the scaled analog portion.

Designing a circuit to discharge rapidly an integrating capacitor in



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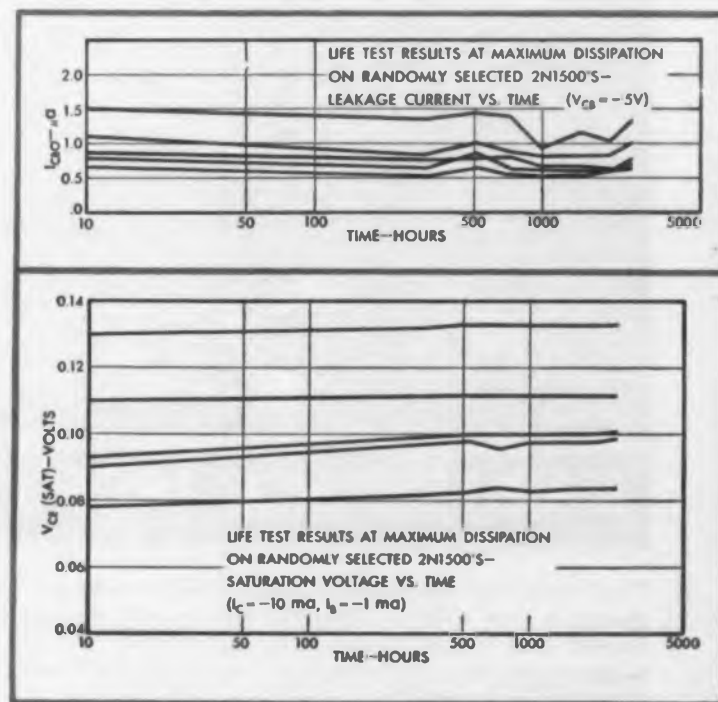
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CIRCLE 10 ON READER-SERVICE CARD

## NEWS

a resettable integrator at the end of each clock cycle turned out to be one of the toughest problems facing the NBS researchers. The bridge circuit diagram, includes a pair of diodes in each arm of the bridge. One of these diodes is a germanium type with a fast recovery characteristic, and the other is a silicon junction diode with high back impedance—on the order of 1,000 meg.

### Integration Must Resume Quickly

The fast recovery is necessary so that integration can resume quickly after the capacitor is discharged at the end of each clock cycle, and the high back impedance is required to hold leakage to a minimum during integration.

The function of the circuit, a diode bridge transmission gate, is to discharge an integrating capacitor at the end of each clock cycle in minimum time, so that the capacitor is ready to resume integration at the beginning of the next cycle.

Output of the integrating capacitor, which is shunted across an operational amplifier, is fed to a summer which sums the result of this analog integration with other integration results required in the total continuous solution.

When no pulse exists in the primary of the pulse transformer at right in the diagram, the diode arrangement is designed to isolate the capacitor from the bridge and transformer. In this condition, the diodes between points 1 and 2 at the top and bottom of the bridge and the secondary coils of the transformer are conducting. This means that point 1 is essentially at  $-10$  v and point 2 is at  $+10$  v, so that the diodes in the bridge are back-biased, effectively isolating the integrating capacitor.

At the end of a clock cycle a pulse of about 0.3- $\mu$ sec duration is applied to the primary of the pulse transformer. This is a positive pulse of at least 20-v magnitude. This pulse drives the top secondary coil in the diagram to at least  $+10$  v, cutting off the diode between this coil and point 1. Similarly the bottom coil is driven to at least  $-10$  v, cutting off the diode between this coil and point 2. Under these conditions, the diodes in the bridge are biased in the forward direction and the capacitor is quickly discharged into the dc sources at the top and bottom of the circuit.

### Leakage No Problem

Because of the high back impedance of the silicon junction diodes, leakage current is not a problem during integration, and because of the



fast recovery of the germanium diodes the capacitor is isolated very quickly after the end of the pulse so that the next cycle can begin.

The machine now planned by NBS will have about 0.01 per cent accuracy using two decimal digits represented by 7 bits plus the overflow value obtained from the analog circuits. A cycle time of 1 msec is being used on the prototype machine, although the clock rate could easily be stepped up considerably for an operating analyzer. A serial adder is planned although parallel adders could be adapted to the machine, according to Mr. Urban. ■ ■

### 11,000 Applying For Permits To Operate Citizen Radio Band

Applications, at the rate of 11,000 a month, are reportedly pouring into the Federal Communications Commission office, for permits to operate Citizen Radio Band.

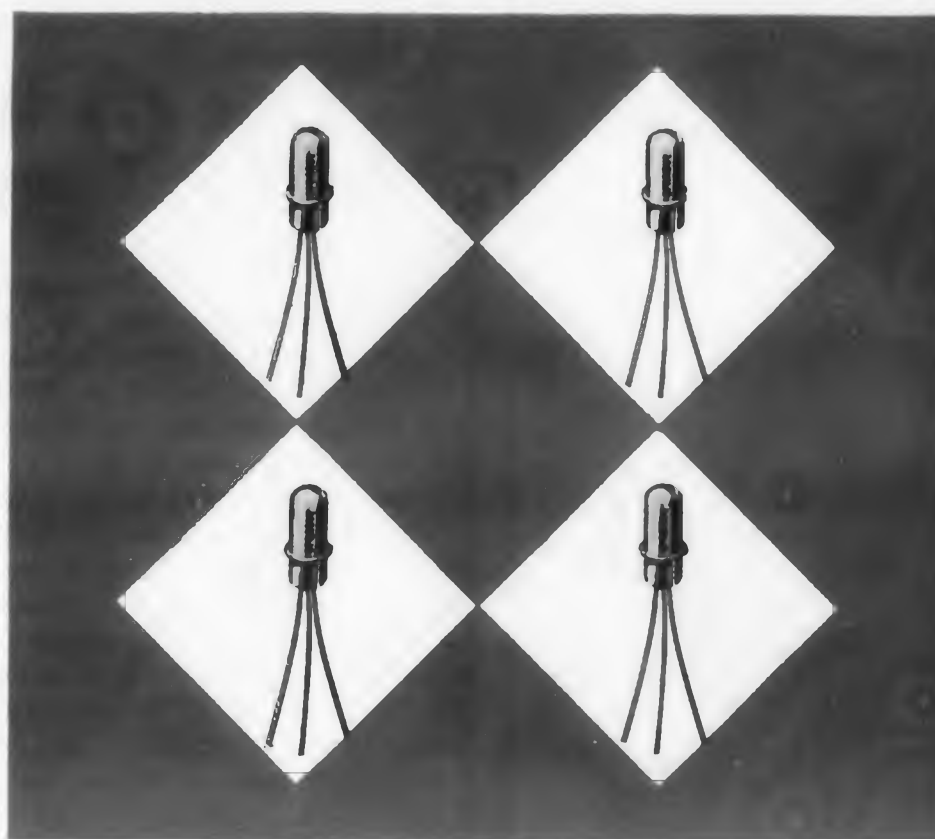
More than 100,000 stations are now using the Citizen Radio Band and a total of 250,000 will be doing so before a saturation point is reached on the 23 channels provided for this service, according to Allan W. Greene, president of the Heath Co., Benton Harbor, Mich.

The band, with ranges up to 10 miles, provides transmission of messages relating to the business or personal affairs of the applicant. Small businessmen are using it to keep in touch with their delivery trucks and servicemen. Farmers, from their homes, direct the activity of their field forces and plant executives talk with foremen in remote units, or keep in touch with inter-plant truckers.

As a result of the high demand for Citizen Band the FCC recently redefined permissible communication in the Citizen Band Service. The new rules prohibit the use of a Citizen Band radio station as a hobby, because frequencies for activities are available on the portion of the spectrum reserved for the Amateur Radio Service. They also require that all communications of a station licensed for the Citizens Band be directed to units within the local ground wave coverage area of the station.

Exchange between units of two or more stations is limited, with few exceptions, to five minutes. A silent period of two minutes is required between each communication. During this period, the frequencies must be monitored to determine whether some other station wants to use them. Transmission of music or other material for entertainment is banned.

The Heath Co., a division of Daystrom, Inc., is a large producer of electronic equipment in kit form and is reportedly servicing many users of the Citizens Band.



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2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

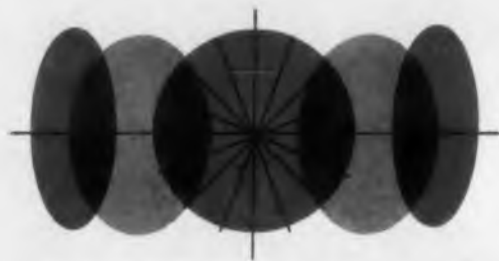
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**FEATURES**—Wide field—plus or minus .2 inches • High resolution—less than .000001 inch • Fast response—5 microseconds • Visible to near infrared—5 to 1.1 microns • Single silicon element • Self-generating • Simple—only four output leads

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XY-20A is sealed, anodized aluminum package, with calibration plot and connecting cable.

XY-20 is shown, with 35° f/10.52, F=1" lens.

For detailed literature and additional information, write or phone:



**MICRO SYSTEMS INCORPORATED**  
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INSTRUMENTATION • GUIDANCE • TRACKING • COMPUTER • CONTROL AUTOMATION

CIRCLE 12 ON READER-SERVICE CARD

## NEWS

# Latin America Still Good Market For U.S. Tubes and Semiconductors

**D**ESPITE increasing competition from Western Europe and Japan, the U.S. continues to be the main supplier of electron tubes and semiconductors to Latin America, according to the Business and Defense Services Administration of the Dept. of Commerce.

A nine-country survey points to a continuing demand for tubes and semiconductors from the U.S. The survey was prepared by the BDSA's Electronics Div., and like a previous survey of selected European countries prepared by the division, shows a strengthening market for these devices.

Highlights from the survey are:

■ **Argentina:** In 1958 the United States supplied about 78 per cent of the electronic components imported by Argentina. The Netherlands, Italy, and the United Kingdom are the next largest suppliers. Domestic production of tubes has increased with the growth of television and the expanding production of TV receivers, radios, and phonographs. This production may stimulate further

production and lessen imports.

■ **Brazil:** Although the United States is the main supplier of tubes and semiconductors to Brazil, ahead of the Netherlands, West Germany and Japan, imports of U.S. products are not expected to increase because of foreign-exchange difficulties. Increased Brazilian production of electronics equipment is expected to reduce the need for imports, except for specialized tubes required for overall expansion of the local industry. A number of U.S. firms have established manufacturing operations in Brazil.

■ **Chile:** Limited consumer purchasing power has restricted the market for radio receivers, and thus decreased the sales of receiving tubes. About 50 per cent of the receiving tubes purchased are for replacement. Imports account for about 40 percent of the Chilean requirements for receiving tubes and total requirements for transmitting and power tubes. The U.S. is the major supplier, followed by the Netherlands and West Germany.

### U. S. Domestic Exports of Electron Tubes<sup>1</sup> and Semiconductors to Selected Latin American Countries, 1959 in dollars

Country of destination	Receiving-type tubes	TV picture tubes	Crt's, n.e.c.	Parts, n.e.c. for tubes <sup>2</sup>	Crystal diodes and transistors n.e.c.
<b>Argentina: 1959</b>	1,933,392	1,603,762	6,173	86,615	321,603
<b>Brazil: 1959</b>	667,239	567,110	6,110	204,055	372,667
<b>Chile: 1959</b>	77,416	—	1,097	45,384	61,820
<b>Colombia: 1959</b>	155,075	27,795	—	—	29,132
<b>Cuba: 1959</b>	554,457	159,444	—	18,778	28,306
<b>Mexico: 1959</b>	1,863,579	25,898	537	310,451	121,633
<b>Peru: 1959</b>	359,788	44,338	1,270	6,968	1,870
<b>Uruguay: 1959</b>	29,664	82,804	—	60,854	12,930
<b>Venezuela: 1959</b>	505,760	99,746	6,152	12,526	14,298

<sup>1</sup>Excludes "Electron tubes, not elsewhere classified" (transmitting, industrial, and special purpose) for which data on countries of destination are not available.

<sup>2</sup>Excludes glass electron tube blanks.  
N.e.c.—Not elsewhere classified.

■ **Colombia:** Electron tubes and semiconductors are not produced locally. Requirements are mainly for receiving tubes and TV picture tubes. Japanese prices reportedly are much lower than those quoted by U.S. and European firms, but price has not yet become a determining factor in imports. The market so far is small and local firms have not encouraged direct investment or licensing operations by U.S. firms.

■ **Cuba:** Electron tubes and semiconductors are not produced locally. Until the recent troubles, imports were supplied chiefly by the U.S., although the Netherlands and Britain have exported some receiving tubes to Cuba. Imports from Japan may provide increased competition. Local conditions will determine the future potential for U.S. electronic products in Cuba.

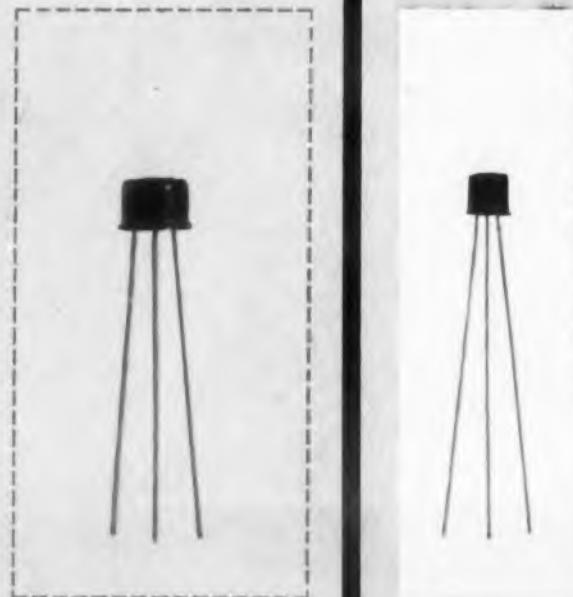
■ **Mexico:** Receiving tubes are in considerable demand, both for the manufacture of radio and television receivers and for maintenance. Four firms are making TV picture tubes; only one firm manufactures receiving tubes. Imports have been supplied mainly by the U.S. It is expected that a new receiving tube plant will be able to supply domestic requirements.

■ **Peru:** The development of television has enlarged the market for electron tubes, all of which are imported. The U.S. is the principal supplier, but competition from Europe and Japan is increasing, particularly in the sale of low-priced receiving tubes. The use of semiconductors has not developed significantly. The Peruvian market is probably too small to justify local manufacture of tubes and semiconductors.

■ **Uruguay:** Only a few types of receiving tubes are manufactured in Uruguay. The U.S. was the principal supplier of electron tubes in 1958 and 1959, supplanting the Netherlands. A sharp decrease in the imports of receiving tubes has taken place since 1956. Radio and television receivers are produced locally.

■ **Venezuela:** Most of the electron tube requirements are met by imports, supplied mainly by the U.S. Increasing quantities, however, are being supplied by the Netherlands, West Germany, the United Kingdom, and Japan. Active sales promotion by dealers handling European products and the price advantage in offerings by Japan are important factors in the marked increase in imports from these areas.

"Electron Tubes and Semiconductors, Selected Latin American Countries," is for sale from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price: 25 cents.



2N696 → 2N717  
2N697 → 2N718

## NEW NUMBERS SAME POPULAR TRANSISTORS SMALL PACKAGE OPTION

### THE FAIRCHILD

2N696 and 2N697 are the world's most copied transistors. We have now copied them ourselves in scaled down versions. The 2N717 and 2N718 are exactly the same as these popular types but packaged in the TO-18 case. They occupy  $\frac{1}{3}$  the volume of the standard TO-5, making them ideal for high-density equipment designs.

With maximum power dissipation of 0.4 watt at a free air temperature of 25°C (or 1.5 watts at a 25°C case temperature), the small packaging still gives more than adequate power handling capability for the majority of applications. All other specifications are identical to those given in the 2N696 and 2N697 data sheets.

These new types are options. Fairchild, as the originator of the 2N696 and 2N697, remains your best source for these most reliable types.

For specification sheets, write Dept. B

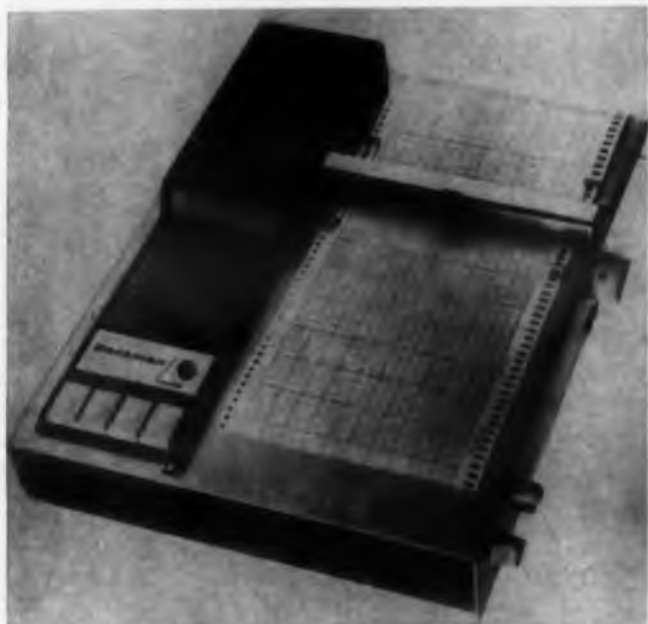
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CIRCLE 13 ON READER-SERVICE CARD

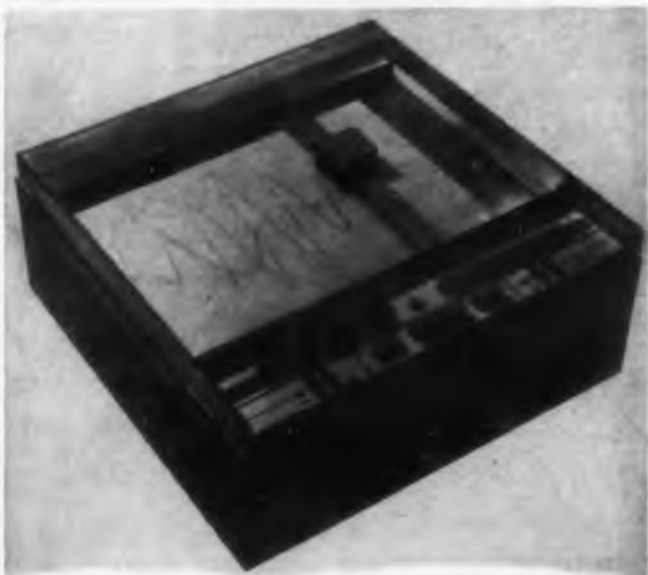




**Potentiometric Recorder** (Beckman Instruments, Inc., Fullerton, Calif.).



**X-L Plotter, Model 300** (Electro Instruments Inc., San Diego, Calif.).

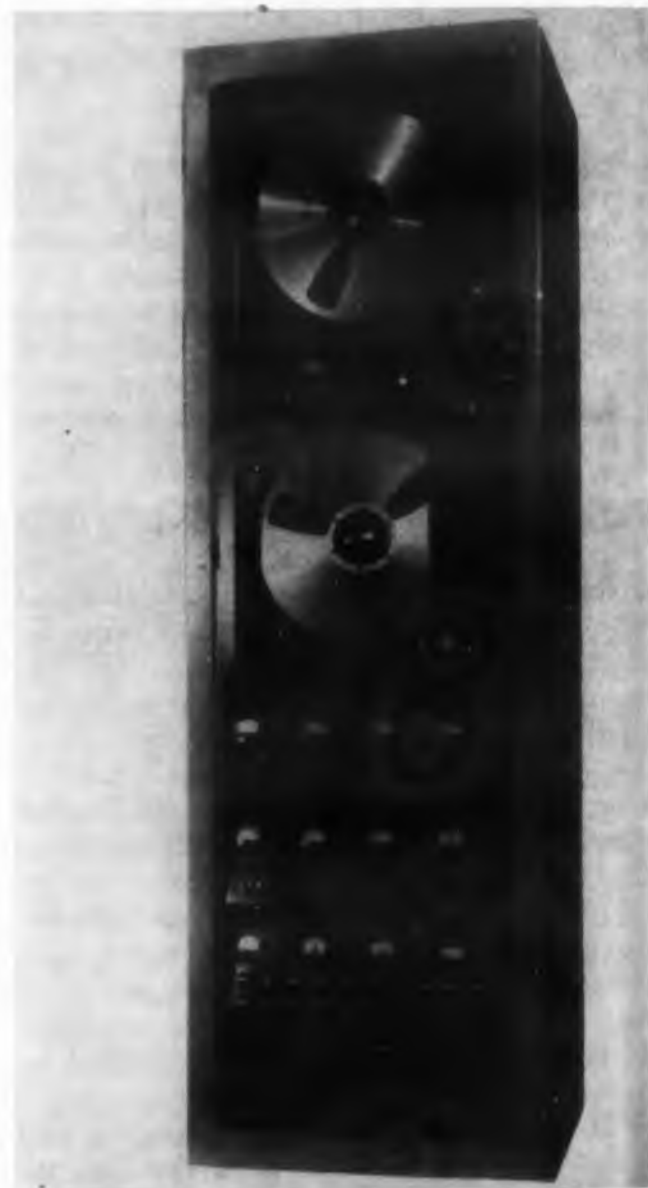


**X-Y Plotter** (Librascope Div., General Precision, Inc., Glendale, Calif.).

## Outstanding Electronic Designs At WESCON



**Digital Tape Handler, TM-1** (Ampex Data Products Co., Redwood City, Calif.).



**Video-Band Recorder/Reproducer, Model CM-100** (Mincon Div., Minnesota Mining & Manufacturing Co., Los Angeles).

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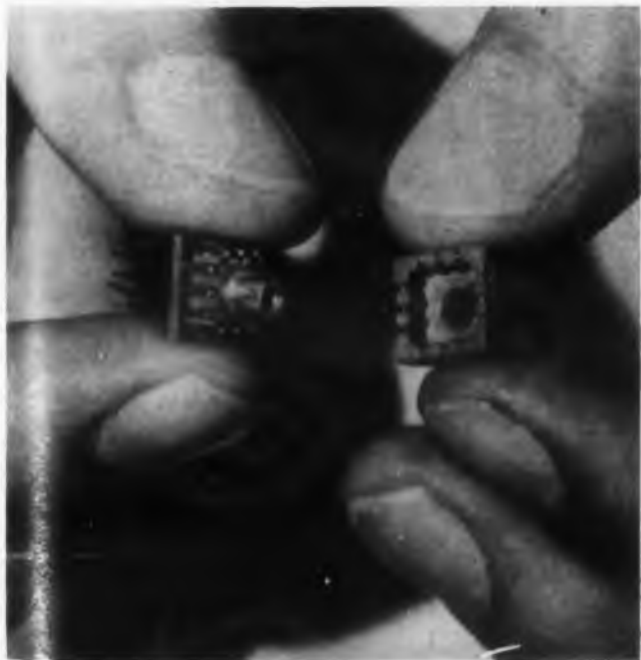
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ELI

**W**ESCON's second annual Industrial Design Awards program, first announced in *ED*, August 3, will feature 22 outstanding electronic designs. Selected by a jury of industrial designers, these products and systems will be highlighted at the Los Angeles Sports Arena. Of the 22 which have received certificates of merit, five will be named "excellent" at show time.

In addition to those pictured here, the certificate winners include:

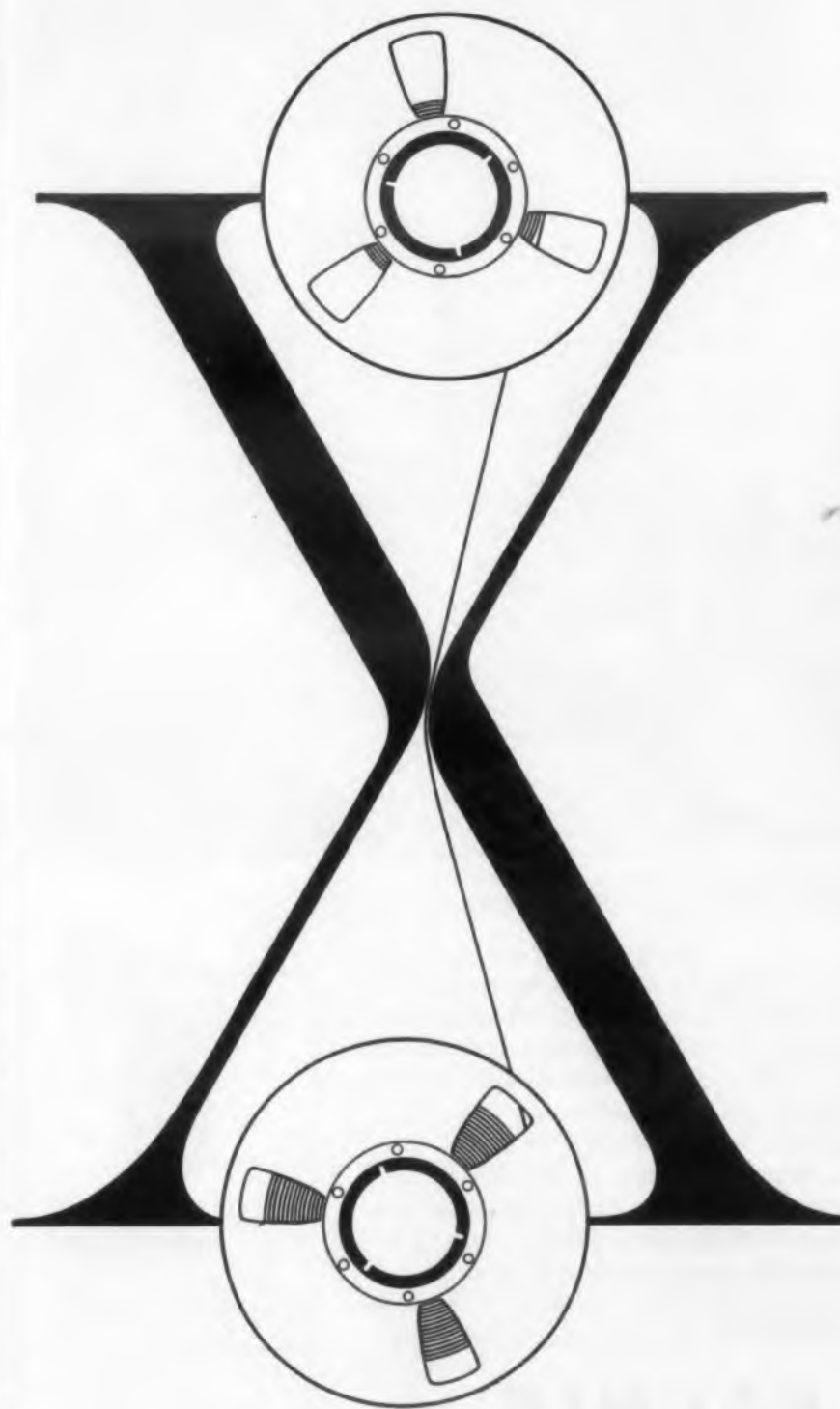
- Panel meters (Voltron Products, Pasadena, Calif.).
- A family of four measuring instruments including pressure meters and sensors (The Decker Corp., Bala Cynwyd, Pa.).
- The FR-600 magnetic tape system (Ampex Data Products Co., Redwood City, Calif.).
- The GE-312 digital control computer system (General Electric Co., Phoenix).
- The G-20 digital computer system (Bendix-Computer Div., Los Angeles).
- The RPC 4000 digital computer system (Librascope Div., General Precision, Inc., Glendale, Calif.).
- The 210 digital computer system (Beckman Systems Div., Anaheim, Calif.).
- An R-W standard cabinet (Thompson-Ramo-Wooldridge, Canoga Park, Calif.).
- NF Fusion sealed resistors (Corning Electronic Components, Bradford, Pa.). ■ ■



**Micro Mod Connectors** (Amphenol Connector Div., Amphenol Borg Electronics Corp., Chicago).

## NO DOUBT ABOUT IT—

*"SCOTCH" BRAND Sandwich Tapes wear 10 times as long without errors*



**I**N THAT NARROW LITTLE LIFELINE OF DATA known as magnetic tape, a miss is magnified into a mile. A missed bit, or one picked up by error is confusing, frustrating and time-consuming. If you're in doubt about the kind of performance you're getting, perhaps "SCOTCH" BRAND Sandwich Tapes can solve some of your tape and equipment problems.

The exclusive construction of the Sandwich Tapes combats the causes of error because it eliminates the source—oxide rub-off and head build-up. Tests prove it wears a minimum of 10 times as long as ordinary tapes before it errs. As a by-product, you can rely on it to drastically reduce maintenance and replacement costs on equipment.

The Sandwich is constructed as shown in the diagram at the right. The famous "SCOTCH" BRAND high potency oxide coating is sandwiched between a tough polyester base and a 50 micro-inch layer of plastic. Since the oxide is never in contact with the head, tape movement is smooth and low in friction—easy on both tape and equipment. Oxide can't rub off and distort valuable data.

Yet, the real meat of this remarkable Sandwich is the "SCOTCH" BRAND high potency oxide coating. Even under the protective plastic, the oxide's potency is quite sufficient to pick up 500 pulses per inch—and give desirable high-frequency response in many AM, FM and PDM applications. Sandwich Tape is but one of the developments to come out of 3M research—the same research responsible for "SCOTCH" BRAND Video Tape—the first video tape in commercial use.

Whatever your application—you'll find the right tape for reliable, error-free performance in the "SCOTCH" BRAND line-up. Check them all. *High Resolution Tapes 158 and 159* pack more bits per inch, offer either standard or extra-play time. *New Heavy Duty Tapes 198 and 199* offer good resolution and exceptional life even in poor environments. *High Output Tape 128* gives top output in low frequencies, even in temperature extremes. And *Standard Tapes 108 and 109* remain the standard of instrumentation.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

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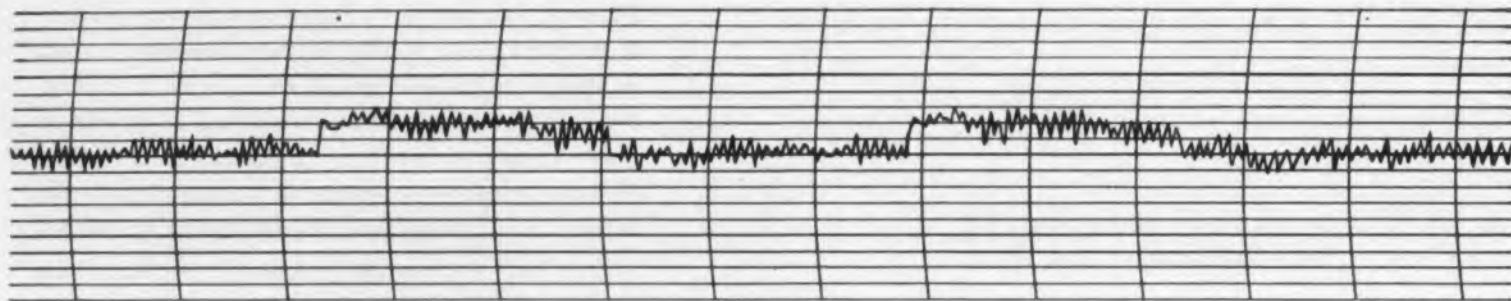
**SCOTCH BRAND MAGNETIC TAPE**  
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY  
... WHERE RESEARCH IS THE KEY TO TOMORROW

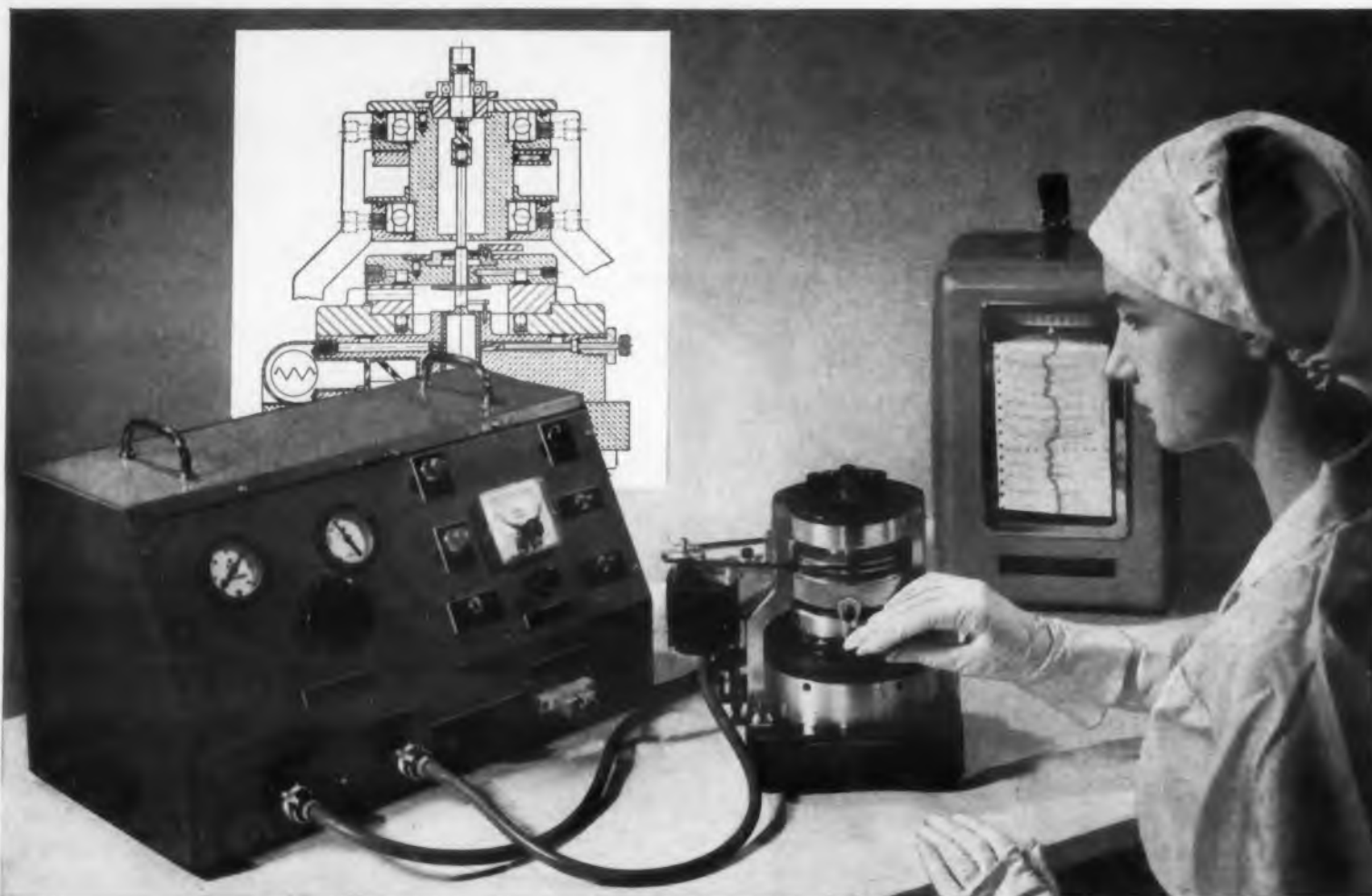


CIRCLE 14 ON READER-SERVICE CARD





## Torque tester with Fafnir Ball Bearings takes instrument bearing "cardiograms"!



Fafnir automatic torque tester checks instrument ball bearings for cleanliness, geometry, surface finish, other conditions affecting performance. Recorder chart provides visual inspection, analysis.

Dirt, handling damage, faulty geometry — these and other ball bearing hazards can wreak havoc in the performance of an instrument or precision mechanism. The automatic torque tester above is designed to detect such conditions before bearings are installed, thus saving costly tear-downs and reassembly. It is widely used by instrument and ball bearing manufacturers.

Two Fafnir super-precision ball bearings support the rotor in this highly sensitive mechanism. These ball bearings must be

as near-perfect as men and machines can make them, to provide the extremely low tolerances for radial and lateral eccentricities, sensitivity, and reliability for which the torque tester is designed.

An exacting assignment for Fafnir precision. But it's typical of the instrument applications in which Fafnir ball bearings have proven themselves. If *your* product design calls for instrument or miniature ball bearings, let Fafnir help you. Write The Fafnir Bearing Co., New Britain, Conn.



Fafnir Super-Precision Ball Bearings support torque tester rotor, provide sensitive, high precision performance.

**FAFNIR**  
BALL BEARINGS



CIRCLE 15 ON READER-SERVICE CARD

## NEWS



Voltage Reference Battery (P. R. Mallory & Co., Indianapolis).



Variable Attenuator (Hewlett-Packard Co., Palo Alto, Calif.).



Precision Standing Wave Detector (De Mornay-Bonardi, Pasadena).



Traveling-Wave Tube, X778 (Eitel-McCullough, San Carlos, Calif.).

ELECTRONIC DESIGN • August 17, 1960

# Captive Quick-Opening Fasteners:

*Southco standards provide many benefits at low cost for access through doors, covers, panels and into drawers*



**Power Triode, X762B** (Eitel-McCullough, Inc., San Carlos, Calif.).



**Signal Generator, Model N-2** (Southwestern Industrial Electronics, Houston).



**Traveling Wave Tube, Type HA-58** (Huggins Laboratories, Sunnyvale, Calif.).

	<p><b>LION 1/4 TURN FASTENERS</b> Quick, positive locking, by fractional turn. Tight seal formed by compression of leaf spring. Alignment and stack height not critical. Approved for aircraft use. Rugged. Extra strength provided by swaged nose. Vibration resistant.</p>	<p><b>FOR COUNTERSUNK</b> </p> <p><b>FOR OVAL HEAD</b> </p>	
	<p><b>RETRACTABLE SCREW FASTENERS</b> Stand-off thumb screws from stock to eliminate costly, special fasteners. Installed quickly without special tools. Accommodate misalignment. Complete range of standard sizes.</p>		
	<p><b>ADJUSTABLE PAWL FASTENERS</b> Pre-assembled, quickly installed. Accommodate variations in frame thickness up to 1/2 inch. One-quarter turn closes, additional turns increase grip pressure. Attractive appearance, long life. Moving or pre-set pawl. Miniature, intermediate and large sizes.</p>		<p><b>MOVING</b>      <b>PRESET</b></p>
	<p><b>ADJUSTABLE PAWL FASTENER</b> Has twin-knob control. One knob controls pawl, pointer shows pawl position. Other knob controls amount of pressure to seal closure with uniform pre-set compression. Easily installed.</p>		
	<p><b>ADJUSTABLE PAWL FASTENER</b> Compact and rugged. Eliminates rivets or bolts to save installation time. Three types cover grip range up to 3/4". Supplied either with integral metal and plastic knob, plastic knob or for your knob.</p>		
	<p><b>ARROWHEAD DOOR LATCH</b> Requires only one hole to install. Operates on quarter turn. Holds under spring tension. Arrow shows pawl position; no pawl stops required. Uses minimum inside space.</p>		

## Free Fastener Handbook

Send for your complete Southco Fastener Handbook, just printed. Write to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.



**SOUTHCO FASTENERS**

© 1959

**LION**

CIRCLE 16 ON READER-SERVICE CARD



## NEWS

### Wideband RF Power Amplifier Installed in HMTS 'Monarch'

Marconi Wireless Telegraph Co. Ltd. of England has equipped a ship, the HMTS Monarch, with hf transmitting equipment which embodies a main amplifier having no tuned circuits.

The equipment consists of two identical wideband amplifiers Type NT 203, separated physically by a central frame housing a switching unit, a coil unit, a monitor unit providing continuous crt monitoring of rf output waveform, and rf load units with rf power measuring probes.

Each NT 203 unit embodies a wideband amplifier with its associated control system and power supply unit. The two NT 203's are connected in parallel by a special combining system for the provision of a peak envelope power of 2.8-w continuous two-tone rating.

Another feature of the NT 203 is its ability to accept conditions of fairly wide load mismatch without damage. The amplifier is stable under conditions of 2:1 mismatch, and closes down in the open circuit condition. The input may be short circuited without disturbing the stability. Reflectometer units are provided to indicate forward power and the voltage standing wave ratio on the feeder system.

### Strap-Down Gyros in Titan System



Guidance-reference system to provide pitch-and-roll programming and a three-axis reference for the Titan missile was developed by the Aeronautical Div., Minneapolis-Honeywell Regulator Co. Three "strap-down" gyros are used in the system, which detects attitude changes in the missile prior to the radio-controlled segment of the flight.

*Sylvania introduces  
a new concept in*

# MICROMINIATURIZATION

*• wafer thin! • feather light!*

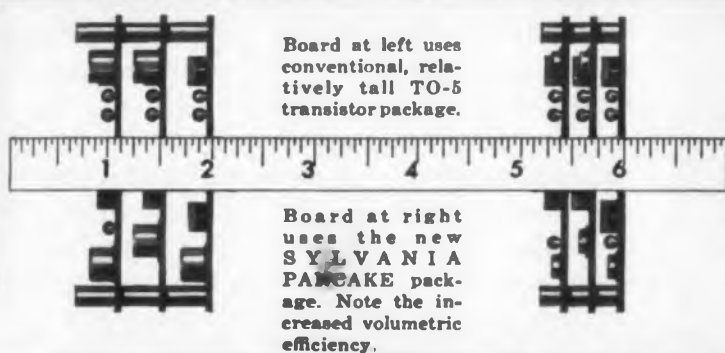
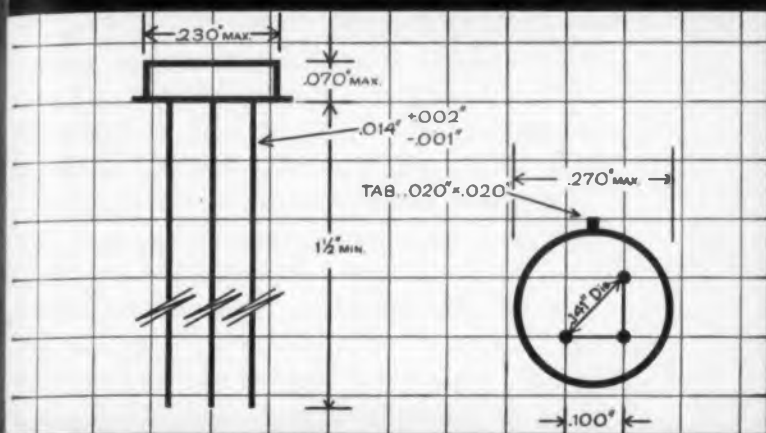
# "PANCAKE" TRANSISTORS

*Now...  
a new  
dimension  
in packaging  
that offers...*

- \* exceptional volumetric efficiency*
- \* correct pin-circle geometry for 100-mil automation grid-system*
- \* performance equal to that of prototypes*
- \* increased ruggedness*

SYLVANIA PANCAKE TRANSISTORS  
SYL-1986 and SYL-1987 shown actual size





Board at left uses conventional, relatively tall TO-5 transistor package.

Board at right uses the new SYLVANIA PANCAKE package. Note the increased volumetric efficiency.

Tentative data

MAXIMUM RATINGS AT 25°C

SYL-1986

SYL-1987

Collector to Base Voltage	-25V	25V
Collector Current	100mA	200mA
Power Dissipation	100mW	100mW
Temperature Range	-55°C to +100°C	-55°C to +100°C
Alpha Cutoff Frequency (min.)*	4Mc	5Mc

\* $(V_{cb} = 6V, I_e = 1.0mA)$   $(V_{cc} = 6V, I_c = 1.0mA)$

PANCAKE TRANSISTORS are SYLVANIA developments. Until a few years ago the art of designing miniature electronic equipment PANCAKE TRANSISTORS are the smaller, lighter in weight than their larger electrical counterparts. PANCAKE TRANSISTORS are smaller in height than the majority of conventional 90-mill transistor tubes. They conventional silver-lead connections.

PANCAKE TRANSISTORS are equipped with leads spaced to fit the 100-mil grid system for automated installation. PANCAKE TRANSISTORS feature clear-glass stress-free bonded with true electrical leads that offer exceptional thermal stability and strength, excellent resistance to thermal shock. PANCAKE TRANSISTORS withstand atmospheric pressures as high as 200 p.s.i., enabling high-pressure package tests for military and industrial quality assurance.

SYLVANIA launches its PANCAKE program with two germanium alloy switching types: PNP type SYL-1986 (electrically similar to 2N404) and NPN type SYL-1987 (electrically similar to 2N388). Many other types utilizing drift, mesa, and alloy-junction techniques are under development at Sylvania.

FOR CONSULTATION on PANCAKE transistor value to your circuit developments, contact your Sylvania Representative. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 188, Woburn, Mass. Sylvania PANCAKE TRANSISTORS also available through Sylvania franchised Semiconductor Distributors.

# SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS** 

## Electronic Imports from Japan Show Sustained Increase

Imports of Japanese electronic equipment during the first quarter of 1960 were almost double those of the first three months of 1959, reports the Electronic Div. of the Business and Defense Services Administration, Dept. of Commerce.

In 1959 the total value of all Japanese electronic products imported into the U.S. rose from about \$8.3 million in the first quarter to more than \$29 million in the last. Imports in the first three months of 1960 even though seasonally declining, reached nearly \$16 million. Largest gains in imports were accounted for by receiving tubes, transistors, speakers, and "sound recorders and reproducers."

Transistor imports increased during the first quarter of 1960 by more than 1,000 per cent over those of the first three months of 1959.

Here is a three-year comparison of U.S. imports of electronic products from Japan:

### Japanese Exports of Electronic Products to the United States January 1958—March 1960

Product	Value in thousands of dollars (1)		
	1958 Year	1959 Year	1960 Jan-Mar
<b>TOTAL</b> .....	21,775	75,642	15,954
Radio Receivers, total .....	17,904	62,373	11,838
Tube type .....	n.s.s.	2,552	833
With 3 or more transistors .....	n.s.s.	57,272	10,004
Other .....	n.s.s.	2,549	1,001
Radio-phonographs .....	59	547	92
Sound recorders and reproducers .....	449	1,617	586
Amplifiers .....	(2)	460	110
Microphones .....	177	321	74
Speakers .....	420	1,155	636
Condensers .....	288	533	145
Receivers (earphones) .....	(2)	619	103
Electron tubes, total .....	314	2,088	762
Receiving tubes .....	n.s.s.	2,034	758
Electron tubes, other .....	n.s.s.	54	4
Transistors .....	7	1,581	336
Other semiconductor devices .....	(2)	92	5
Phonograph parts and accessories .....	757	824	193
Other electronic products ..	1,400	3,432	1,074

(1) Converted to U.S. dollar equivalents at the rate of 360 yen = U.S. \$1.00.

(2) Not shown separately prior to 1959; value included in "Other electronic products."

n.s.s. Not shown separately.

Sources: Data obtained by the U.S. Embassy, Tokyo, from the Japanese Ministry of International Trade and Industry.



Synthane makes and fabricates  
laminated plastics



## Why "do-it-yourself" fabrication seldom pays

This is a "long length" saw, especially built to cut sheets of Synthane laminated plastics of over 25 feet in length.

It is extremely improbable that you would ever have sufficient work to make the purchase of such a machine profitable. Yet the long length saw is only one of hundreds of unusual machines necessary for

fast, accurate, economical fabrication of laminates.

Without the advantage of special machines and tools, and faced with the possibility of errors, waste, delays, mistakes in tolerances or dimensions—at your expense—you may come to the same conclusion as have nearly all of our customers—buy your lam-

inated plastics from us and have us fabricate them for you. Call any of our representatives—located in all principal cities—for a quotation or write to Synthane Corporation, 42 River Road, Oaks, Pa.

**SYNTHANE**  
CORPORATION **S** OAKS, PENNA.  
Sheets • Rods • Tubes • Fabricated Parts  
Molded-laminated • Molded-macerated

*You furnish the print—we'll furnish the part*

CIRCLE 17 ON READER-SERVICE CARD

## NEWS

### ICBM Attacks on U.S. Simulated In Two Data-Processing Systems

Intercontinental ballistic missile attacks on the U.S. are being simulated in the form of magnetic tape and then fed for test purposes into two huge data-processing systems.

The two Radio Corp. of America systems at Van Nuys, Calif.; one destined for the North American Air Defense Command at Colorado Springs, Colo., and the other for the Strategic Air Command Headquarters at Omaha, Neb., are now linked for test purposes by a communications "loop" through San Fernando, 10 miles to the north. The operation when in actual service is:

- The data transmitted from all forward sites are received at Colorado Springs and Omaha and combined and processed in a central Display Information Processor (DIP). Missile threat information and threat summary data indicating detailed raid information are projected on a large screen. Site equipment status is shown on a small console in a monitoring room.
- Automatic processing of a missile attack from the moment of recognition of a mass raid by the site computers to the display of the threat at NORAD and SAC requires an average time of about 8 seconds. Data on individual missiles will be displayed at NORAD within 3 seconds after missile discrimination.
- In the event of failure of automatic transmission equipment, a manual back-up method is available for receiving data by phone or teletype and mechanically inserting it into the computer display equipment.

### Frequency Allocations for Robots Requested From FCC by Hughes

Radio-controlled robots can't stomach interference, therefore it is up to the Federal Communications Commission to allocate specific frequencies for robot operation.

This is the contention of a petition submitted to the FCC by Hughes Aircraft Co., Culver City, Calif., for 100 mc within the 13 to 35 kmc region.

The Hughes request is based on the Mobot Mark I which is now in operation at Sandia Corp.'s Engineering Reactor Facility, Albuquerque, N.M. The Mobot, which is cable controlled, is designed to move objects in a room where radiation is too intense for a man, even with pro-

ELECTRONIC DESIGN • August 17, 1960

ective clothing. Moving objects from room to room, where heavy concrete doors must be opened and closed, is impossible with the cable controlled robot, Hughes pointed out in the petition. Radio control would solve this problem, but interference could not be tolerated.

There are many other applications where radio-controlled Mobots can be used, according to Hughes, and development of the concept for these uses is progressing. Among those mentioned were: fire-fighting in forests, chemical plants, oil fields, and similar hazardous areas; in munitions factories; disarming warheads; programmed warehouse stacking; underwater manipulation; space exploration and performing experiments in hot laboratories.

Hughes asked that allocation be made to Safety and Special Radio Services, and recommended that each frequency assignment or shift of a Mobot using a specific frequency be checked carefully so that interference would never be possible. Since hazardous operations and expensive equipment would be involved, there should be absolutely no possibility of interfering signals Hughes feels.

Provisions should be made for TV as well as control frequencies, Hughes points out, because remote operation will require TV observation of Mobot activities. The 100-mc allocation should meet this requirement, Hughes says, and still allow more than one Mobot to operate in the same area.

## Experimental Self-Coating Ceramic

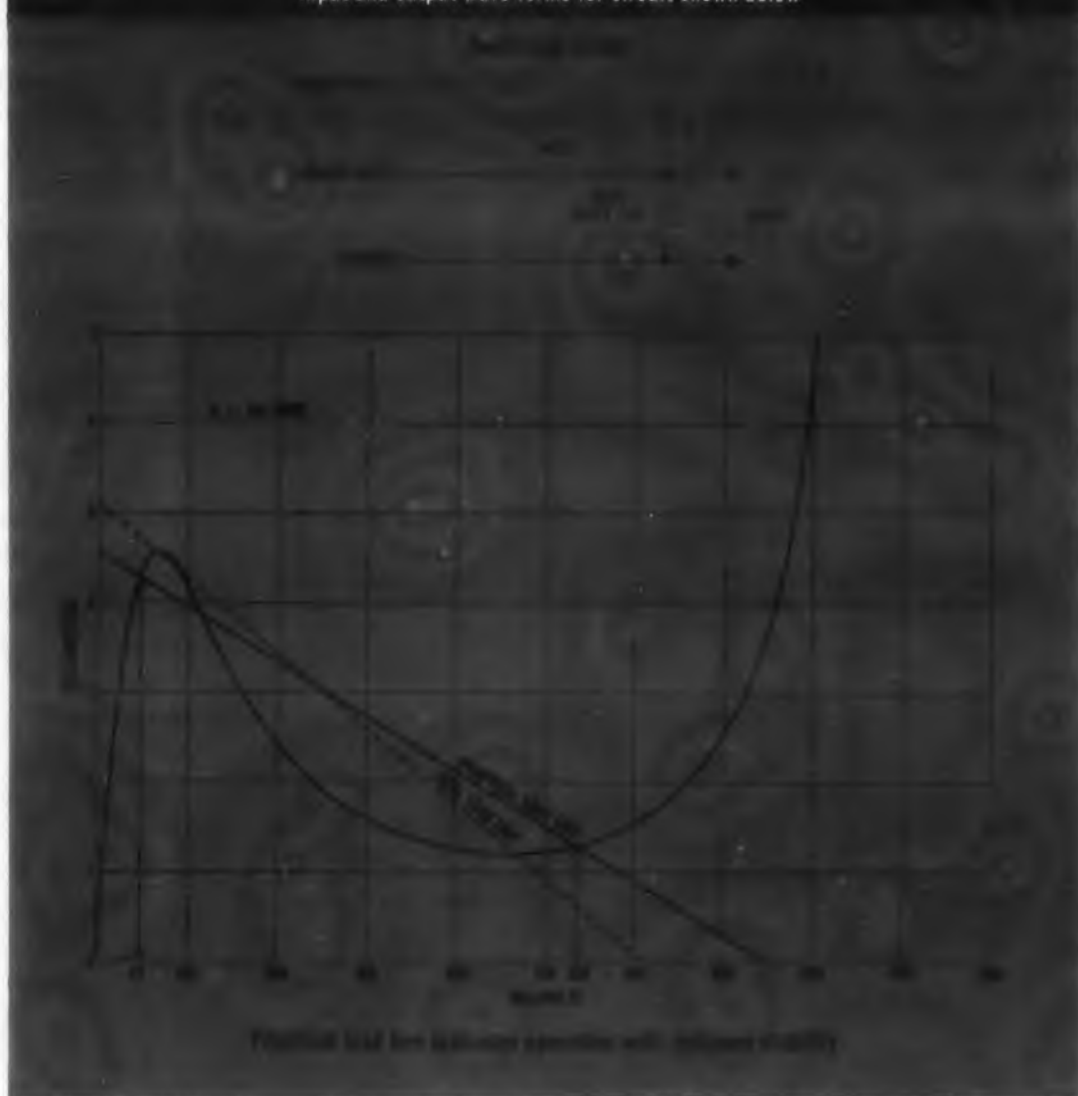


An experimental ceramic graphite-base material which spontaneously forms its own protective coating against heat and oxidation is being studied at Boeing Airplane Co. of Seattle for possible use in ultrahigh-speed flight. The maximum tension and compression capability of the material is about double that of standard graphite at room temperature. A typical composition consists by weight of 50 per cent graphite, 24 per cent molybdenum disilicide and 25 per cent titanium boride plus minor ingredients for bonding.

ELECTRONIC DESIGN • August 17, 1960



Input and output wave forms for circuit shown below



See our display at WESCON  
Booths 944-45-46



TO-18 Case

—FOR THE HIGHEST  
0/1 VOLTAGE RATIO

—FOR THE WIDEST  
RANGE OF  
PEAK CURRENTS

...SPECIFY HOFFMAN  
SILICON TUNNEL DIODES

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1N2933	47 mA
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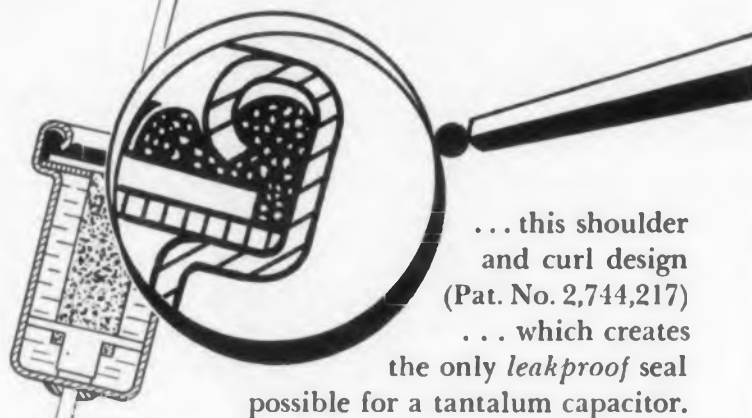


Mr. Ramsey\*-

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WHERE RELIABILITY DICTATES STANDARDS

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## WASHINGTON REPORT



Ephraim Kahn

MORE INDUSTRY PARTICIPATION in the NASA space-exploration program is promised by Administrator T. Keith Glennan. An "increasing proportion" of NASA's work will be done by industry on a contract basis—and companies will be expected to provide "a substantial part of the initiative" in suggesting projects. The probable size of NASA's program is considerable, and will certainly involve a significant amount of electronics. Eventually, more than 75 per cent of NASA's budget—which will climb to more than \$1.5 billion annually in the course of this decade—will be spent with industry and with educational and other non-profit institutions. This year, the agency has about \$915 million to spend.

NEGOTIATION OF CONTRACTS has been vigorously defended by the Pentagon in the face of persistent Congressional attacks. Competition exists in negotiation, the military insist, adding that negotiation is "nothing more or less than the application of sound business principles, specifically tailored to each particular weapon or piece of research." Use of formal advertised bidding in all cases would "require static specifications which would yield obsolete equipment and would preclude placing contracts with companies offering the advanced designs."

DESIGN COMPETITION is a major factor in competitively negotiated military contracting. Design and technical knowledge provide a "grueling competitive test" for firms in the electronics and other fields that seek military business. Survival of this initial test, in which fine creative technical brains are pitted against each other, normally means that the Defense Department will continue to maintain or add related contractual relationships with the winner of the initial competition. This normally will persist until the item in question becomes sufficiently standardized to be purchased under competitive bidding or until the particular program is complete.

MORE DEFENSE SPENDING is implicit in the platforms of both political parties. Timing is in question. The President has indicated that he will try to hold back as much as possible of the extra \$700 million that Congress voted to the military in the current fiscal year. The military, aware of the impending change in the political scene, is believed to be already making plans for using between \$1 billion and \$2 billion extra.

CONGRESSIONAL CHANGES in ground rules for contract negotiations are not likely to take place this year. The House, at the behest of Chairman Vinson of the Armed Services Committee, passed a bill which would, among other things, stop the military from justifying contract negotiation on

the ground that a national emergency exists. This bill is pending before the Senate Armed Services Committee. Since its procurement subcommittee is working on a report on defense buying practices, the committee probably will want to consider this before taking any action on the House bill.

AIR DEFENSE RADAR will be tested as a unit on September 10, including all related electronic gear. Test will involve both U.S. and Canada and will entail restriction on civilian flying "for a brief time." As the North American Air Defense Command—which has been conducting air defense exercises for some time—sees things, "however perfect any system may be, it cannot be relied upon until it has been thoroughly tested."

DESIGN COORDINATION for communications equipment will be one of the jobs of the Pentagon's new Defense Communications Agency. It will be responsible for drawing up specifications for high-level long-haul military communications operation and will set guidelines on the Armed Services' participation in R&D on communications. Purchases of communications equipment by each of the Services will have to be cleared with the new agency to insure compatibility. Much actual communications system control will be carried out with the aid of electronic data processing machines, according to the Agency's present plans.

SMALL FIRMS' CONTRACTS under the set-aside program of the Small Business Administration reached a record high in fiscal 1960. Little companies received 24,152 awards valued at \$878,168,714. Number of pacts declined from last year's 24,800 though there was an increase of four percent in their value.

HIGHEST-LEVEL CLEARANCE is required when the Army negotiates certain types of contracts, according to the Judge Advocate General of the Army. Six kinds of contracts must be approved by the Secretary of the Army, or by a designated second-echelon official. They include pacts for: (1) research, exploratory, or development work; (2) classified products; (3) technical devices which must be standardized and have interchangeable parts; (4) technical or specialized items which require a substantial initial investment or which need extensive pre-manufacturing preparation; (5) purchases which the military have been unable to buy satisfactorily through formal advertised bidding; and (6) purchases in the interest of national defense or industrial mobilization. There are some exceptions to the top-level approval requirement. In periods of national emergency, R&D contracts valued under \$100,000 may be negotiated without Secretarial approval. Pacts with educational institutions are exempt regardless of value.

PUSH-BUTTON COMMUNICATIONS SYSTEM will be commissioned in October by the Federal Aviation Agency. This is a channel-switching system, one of the first parts of the highly automated air-traffic control system that FAA expects to put into operation over the next few years. First locations of the new switching system links are Atlanta, Ga., and Oakland, Calif.

# WATER

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Now the water is ready for use — in the critical chemical cleansing process of Fansteel silicon rectifier junctions. Thorough washing of the silicon rectifier junctions in this ultra-pure water results in contaminant-free junctions . . . and another assurance of complete Fansteel silicon rectifier reliability.

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## NEWS

### Patent Applications Trail Large-Scale Research Boom

The large-scale research boom has not greatly increased patent applications. While research efforts are up six to 12 times over the past couple of decades, patent applications have risen only one-sixth, according to patent officials.

These officials believe the patent lag behind research efforts can be attributed to the following factors:

- The increasing complexity of modern technology, with invention piled on invention, may have developed to a point where the end product involves one solution of which there are other variants available, so that the motive for patenting is not so great.

- As the body of patent and technical literature becomes greater and greater, it becomes more and more difficult to produce a patentably novel invention.

- The inhospitable attitude toward patents exhibited by some courts may discourage patenting.

### General Telephone's Dr. Conwell Receives Distaffer's Accolade

The Society of Women Engineers has presented their annual award to Dr. Esther M. Conwell of General Telephone and Electronics Laboratories Inc. of Bayside, N.Y.

Dr. Conwell received the award from Catherine Eiden, president of the association, in recognition of her work as a research physicist in the field of solid-state research.

### CHANGES IN PRICES AND AVAILABILITY

**METAL FILM RESISTORS** with 150 ppm TC in tolerances of 1 per cent and 1/2 per cent have been reduced in price up to 60 per cent by Electra Manufacturing Co. of Kansas City, Mo. Called the T.O. series, this precision component is available in three sizes: 1/8 w, 30 ohms to 500 K, 1/4 w, 50 ohms to 1 meg; and 1/2 w, 1.5 meg.

**ENCAPSULATED TRANSISTOR DIGITAL CIRCUIT MODULES** have been reduced 5 per cent to 30 per cent in price by Epsco, Inc. of Cambridge, Mass. Epsco is now marketing encapsulated flip-flop circuits from \$25 up and transistor logic circuits from \$14 up. These items are available for immediate delivery from stock.

CIRCLE 21 ON READER SERVICE CARD ▶

ELECTRONIC DESIGN • August 17, 1960

## Orbiting Tiros Satellite Transmitted 22,952 Photos

Tiros I, the 270-lb satellite orbiting at altitudes averaging 450 miles, has reached the end of its orbiting life. Transmission of 22,952 picture frames has given meteorologists unprecedented opportunity to study the earth's cloud cover and relate it to weather.

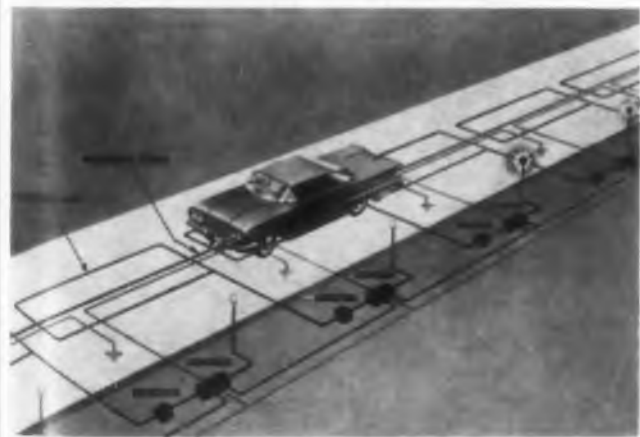
The decision to discontinue attempts at interrogating Tiros I was made after Orbit 1,302 over Fort Monmouth, N.J. The wide-angle camera system and all telemetry had ceased to function. The 108 mc tracking beacon continued to operate.

There appeared to be some limited operational capability remaining in the narrow-angle camera system. It would, however, be extremely difficult, perhaps frequently impossible, for meteorologists to identify and orient the narrow-angle camera pictures. The satellite's attitude sensors were not working and there were no longer wide-angle photos, which frequently picked up identifiable geographic landmarks, to assist scientists in orienting narrow-angle cloud cover photos.

Scientists believe an inoperative relay in the wide-angle camera system was probably the cause of Tiros' difficulty. The malfunction made it impossible for the camera to turn it off. This apparently drained the batteries and eventually caused the wide-angle camera transmitter to burn out. This damage seemed to have affected the entire satellite system.

The next experimental meteorological satellite, Tiros II, is planned for launching later this year.

## Electronic Highway Guides Autos



Basic elements in this buried electronic highway system are an arrangement of circuits for detecting vehicles and a guidance wire to provide a steering signal. The detection system consists of a wire loop and a transistorized device placed off the road. Signal from detection loop enters control unit (being adjusted in inset) which controls speed of following autos. The experimental system combines electronic techniques developed by Radio Corp. of America and car controls developed by General Motors Corp.

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## NEWS

### Iono and Tropo Scatter Used in Transpacific Communications Net

A 6,500-mile, transpacific military communications system using ionospheric and tropospheric scatter techniques has recently become operational. The system extends from Hawaii to the Philippines and is said to give more than 99 per cent reliability in handling of military communications in an otherwise difficult region.

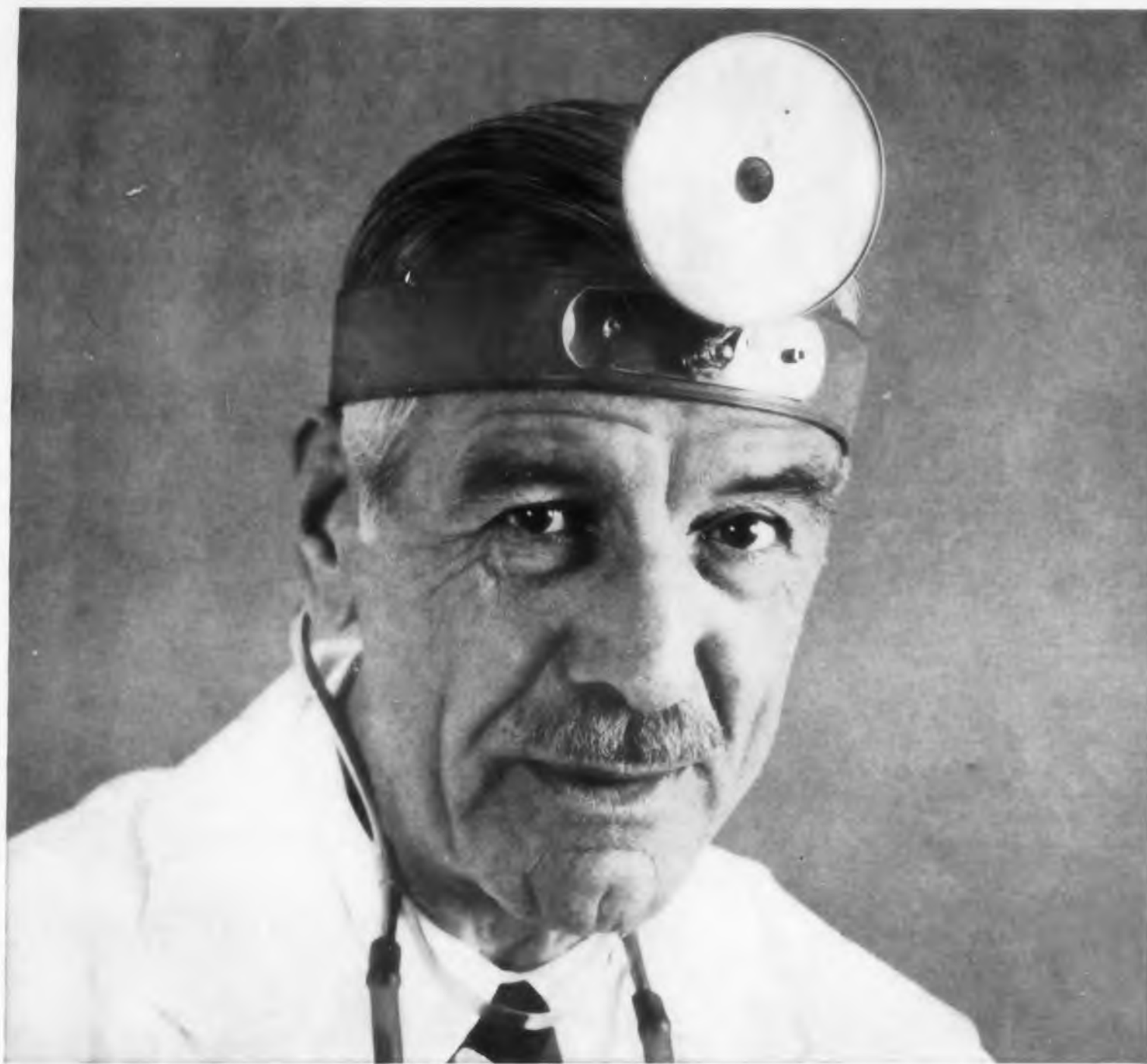
Eight interconnected stations, separated by more than 1,000 miles on the average, comprise the system. The eastern terminus at Oahu, Hawaii, is tied to the first station at Kauai, about 150 miles away, by a tropo-scatter link. The 1,000-mile distances between the other stations are bridged by iono-scatter links.

The system required more than three years for design and construction; electronic equipment costs exceeded \$35 million.

Redundant design provides maximum operational reliability. A total of 29 high-power transmitters are installed at the eight stations. Spare transmitters and receivers are automatically phased into and out of operation to equalize the duty cycles of all units.

The iono portion of the system operates in the 34-37 mc and the 49-55 mc bands; power output is classified. System capacity consists of 16 teletype channels transmitting at 60 words per minute each and a voice channel for use in coordinating and maintaining the network.

Receivers have a sensitivity of  $-160$  dbw and a dynamic range of 100 db. Antenna design is unique in that both the high powered transmitted



## The Extreme Case of Shipmentitis

The most extreme case of Shipmentitis on record dates back to the General who lost the War because during the crucial Battle he couldn't locate the nail for his horse's shoe.

Today, Shipmentitis is a disease that afflicts many electronic component users. Its symptoms are occasional shipments arriving late, or in the wrong place, or incomplete, or with the wrong specifications. Some Companies have a slight case of Shipmentitis without realizing it. In serious cases, Shipmentitis can delay vital defense projects, cause expensive setbacks.

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"Piggy-back" dual frequency corner reflectors of the Kauai station of the transpacific communications system. Stacked arrays rise 400 ft above the island. The two parabolic reflectors are for the tropo scatter portion of the system.

signals and the low power incoming signals are handled simultaneously by the same corner reflectors. Branching filters are employed for signal separation. Considerable effort went into minimizing antenna noise. All joints are heliarc welded to prevent loose connections and attendant arcing. Connections between dissimilar metals were carefully engineered to minimize corrosion.

The tropo link employs modified AN/FRC-39 equipment manufactured by Radio Engineering Laboratories, Long Island City, N.Y. Tropo power is 1 kw at 755-985 mc.

System engineering for the transpacific network was performed by Page Communications Engineers, Washington, D.C. Radio Corp. of America supplied the transmitters, National Co. the receivers, and Radio Engineering Laboratories the fm modulators and certain auxiliary line-of-sight equipment for input and output to the system.

### Three New England Stations In Ionospheric Research

Three ionospheric research stations, a master and two slaves, are operating in New Hampshire and Vermont. Scientists hope that the data provided will contribute to basic knowledge and be useful in improving long-range radio communications.

Specifically, the two stations seek data about the movements of dense concentrations or clouds of electrons in the ionosphere, and the angle at which atmospheric "whistlers" enter the atmosphere.

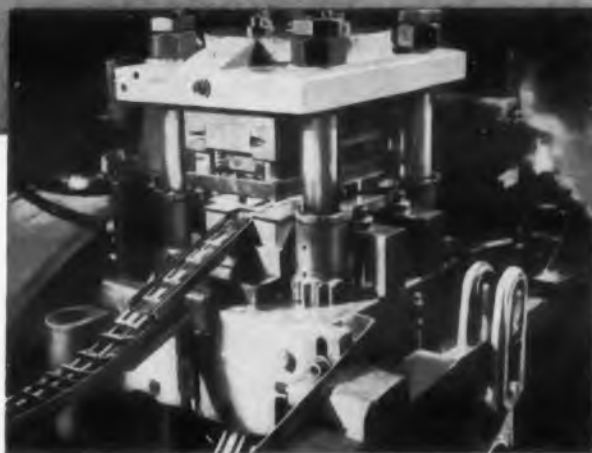
The data obtained are expected to prove or disprove observation made by other methods about the movements of clouds of electrons and their effects on radio-wave propagation in the E layer of the ionosphere.

Equipment in the two slave stations is synchronized through high-quality telephone lines with the master unit. The transmitting unit at the master station, a vertical incidence ionospheric sounder, sends out 60 radio impulses per second. These sweep rapidly across a wide frequency range, from the broadcast to short-wave bands. All three stations record the echo of the impulses off the clouds of electrons. Through slant triangulation, the speed, height and direction of the clouds can be determined.

Whistlers, the program's second phase, are a special kind of natural radio signal. They are believed to be caused by lightning discharges that travel from one hemisphere to another along the lines of the earth's magnetic field. By measuring the time of arrival at the three stations, the angle of arrival of the signals can be deduced.



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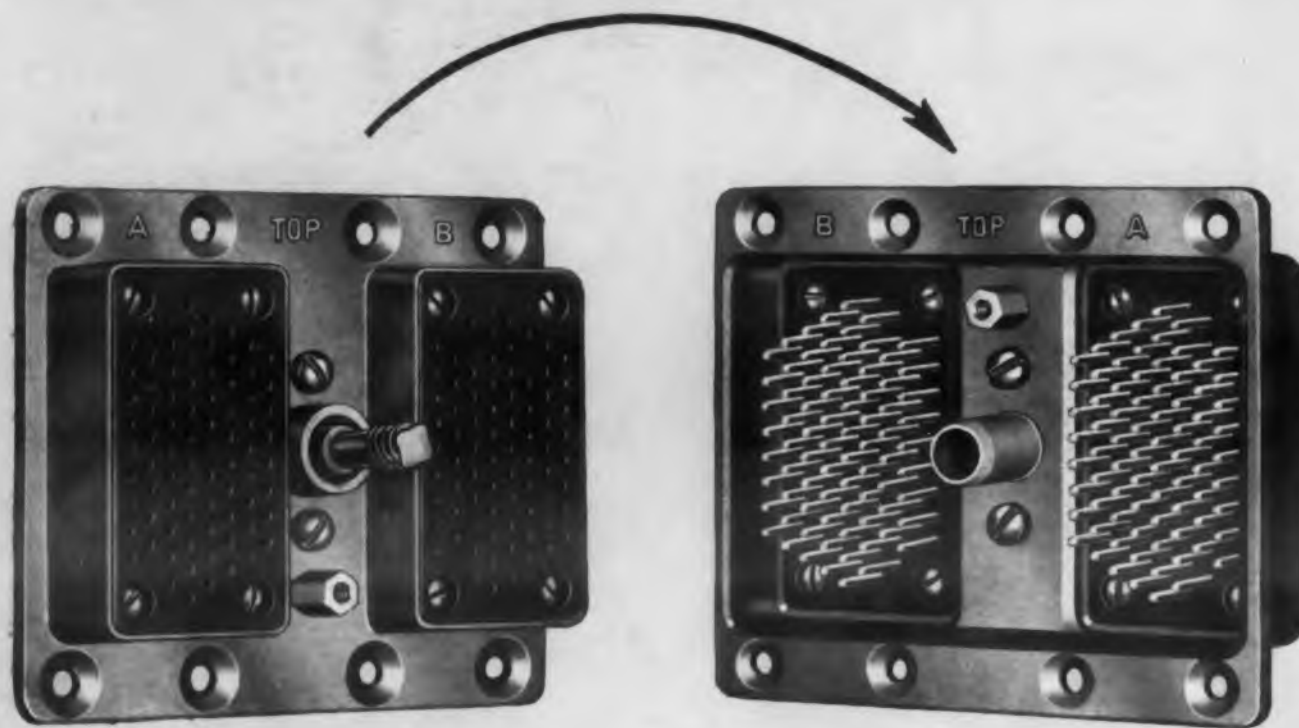
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## NEWS

### Simplicity Is Keynote

Manufacturers in the ultrasonic-cleaner field have simplified their equipment to the point where an operator merely turns an on-off button.

Two manufacturers offer on their standard models features that automatically maintain peak efficiency regardless of changes in the cleaning fluid. Formerly, a trained operator had to tend the machines and watch for deviations from normal operation—signs that the liquid level, operating temperature, or work load had changed. The two manufacturers are Narda Ultrasonics Corp., Westbury, L.I. and Powertron Ultrasonic Corp., Garden City, L.I.

A third manufacturer, Branson Ultrasonic Corp., Stamford, Conn., offers a compensation device optionally, but maintains that its equipment is designed so special compensation is unnecessary for most cleaning jobs.

Generally the compensation technique used is to change the frequency at which the electrical-to-acoustical conversion transducers are driven.

The Narda unit achieves compensation by generating instead of a single frequency, a 10 kc spectrum centered around 22 or 40 kc (depending on the model). A signal is generated by a single-tube power oscillator. The signal is amplitude modulated by pulses to generate a small range of sidebands close to the carrier. The oscillator signal simultaneously is frequency modulated by feeding these pulses to a saturable inductance. Hence, the carrier and its tight sideband pattern is translated through a wide frequency range.

The spectrum is swept non-linearly once every 1/60 sec (the modulating pulses are keyed to the power lines).

Narda uses a transducer of ceramic doped with barium titanate. According to the company, "The generation of a whole spectrum of frequencies exploits the tendency of the transducers to vibrate in many modes." The company offers two types of transducers. One has an upper temperature limit of 160 F; the other's limit is 212 F.

The only Narda unit now on the market has a 5-gallon tank capacity and a power rating of 300 w. The company expects to market soon additional models in larger and smaller sizes.

The Powertron unit operates at only one frequency at a time. Cleaning-fluid variations that make it desirable to change the frequency are sensed, and fed back to the single-tube power oscillator. The oscillator frequency changes in response to the phase of the fed-back signal.

This phase depends on the phase of the sound reflected from the surface of the cleaning fluid. The oscillator changes frequency by an amount

## In Ultrasonic Cleaners

sufficient to keep the fed-back voltage in phase with the grid voltage.

The sensing device is identical to the transducer—barium-titanate- and cobalt-doped ceramic—and is mounted alongside the transducer. Both units are sandwiched between aluminum blocks.

The oscillator operates at a nominal frequency of 28 kc. The frequency varies, under load conditions, between 26 and 30 kc. The upper temperature limit of the transducer is 212 F, according to the company.

The Powertron unit comes in five sizes, as denoted by the average generator power—100, 200, 300, 700 and 1,000 w.

Branson's standard units do not compensate for changes in the level of the cleaning fluid. Such compensation is obviated, according to the company, by mounting the transducers on the side of the tank instead of on the bottom. Thus, the distance from the acoustical source to the reflection surface—the opposite side wall of the tank—is constant.

The temperature changes are compensated by heating-cooling coils surrounding the cleaning tank. The coils respond to a thermostat.

The transducers—lead zirconate—are insensitive to temperature changes, according to the company, and have a flat frequency response. Hence, variations in the acoustical standing wave pattern do not adversely affect their ability to deliver acoustical power. The transducers operate at 25 kc, and have an upper temperature limit of 200 F.

Branson units come in standard sizes between 50 and 1,000 w. The company would not explain the principle behind its optionally available automatic compensation units.

All three companies said the electrical-to-acoustical conversion efficiency of their transducers was about 90 per cent.

### 'Aerospace' to Replace 'Aeronautical' in IAS Title

The council of the Institute of the Aeronautical Sciences, at a meeting in Los Angeles, voted unanimously to submit a name change to its membership for approval.

It recommended that the now universally accepted word "Aerospace" be substituted for the word "Aeronautical" in the title by which the Institute has been known since 1932. If the membership concurs, the organization will become officially the "Institute of the Aerospace Sciences." The long established and familiar "IAS" will remain unchanged.



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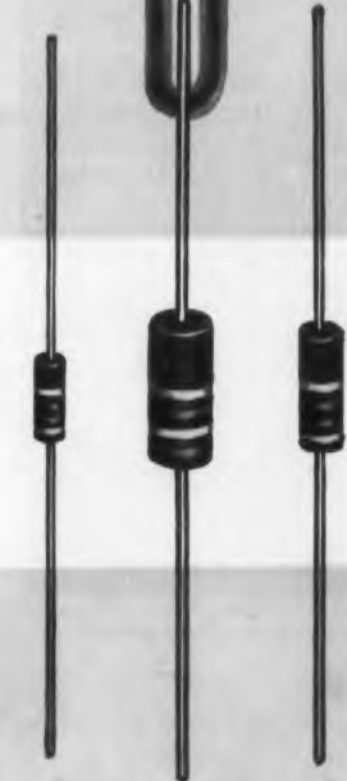
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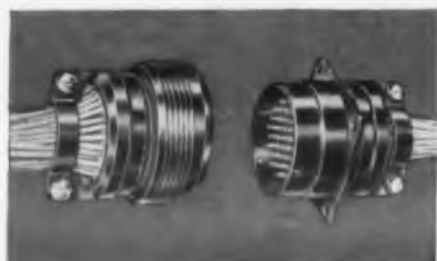
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# NEW from

## AMPHENOL

CRIMP POKE HOME® CONTACTS give plus value to each of the five AMPHENOL connector families illustrated below. Crimped *outside* of the connector by hand or power tool, Poke Home contacts are quickly inspected and easily inserted. The strength and uniformity of the crimp provide the *most reliable means of wire termination* available.

Poke Home contact crimping is being demonstrated at booths 848-849. Stop by and see *reliability at work!*



**48 Series** Connectors to MIL-C-26500. Performance unaffected by 1000 hours at 200°C. 3 shell styles, 4 to 55 contacts.



**69 Series** Poke "R" Connectors. Upgraded MIL-C-5015-type "R" construction. 3 shell styles, sizes 10SL through 36.



**17 Series** Min Rac 17. Space- and weight-saving miniature rack & panels. 9 to 50 contacts. Cable clamps available.



**93 Series** Complete family of rack & panel, cable-to-chassis, cable-to-cable connectors. 34, 42 and 50 contacts.



**94 Series** Up to 63 contacts, coax. connectors in some inserts. Primarily rack & panel, but cable clamps available.



# WESCON Extra!

Come see how small connectors are getting—special display of new Micro-Miniature components!

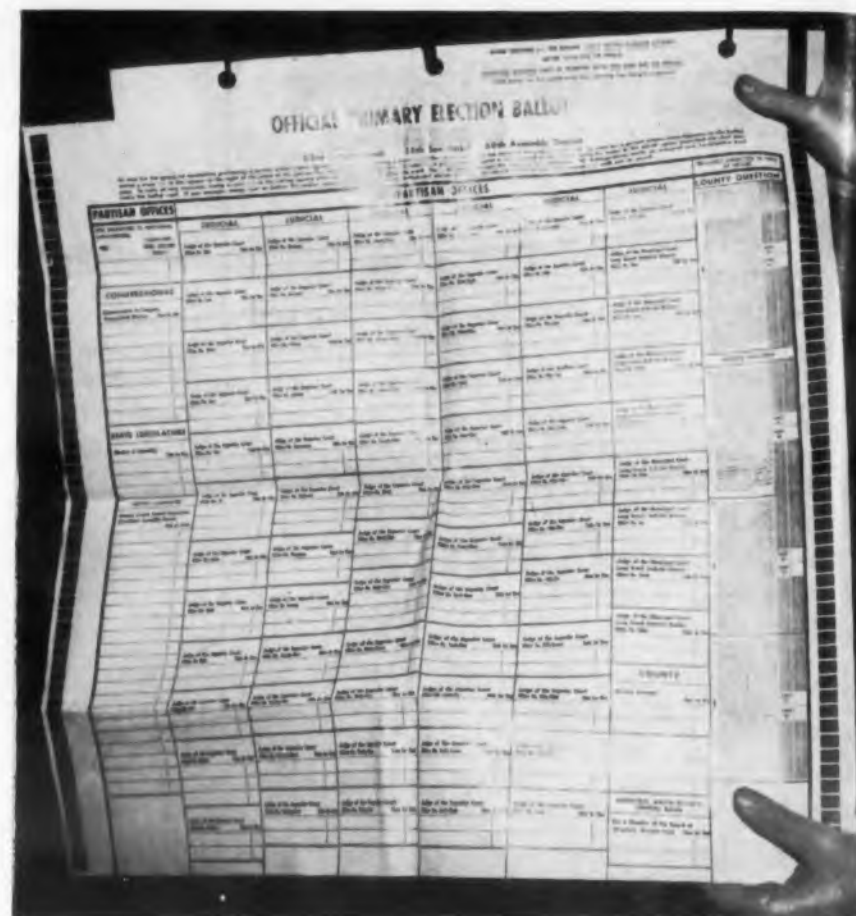
# WESCON

## AMPHENOL

Booths 848 & 849

Amphenol Connector, Cable & Wire and Western Divisions  
Amphenol-Borg Electronics Corporation  
Broadview, Illinois

## NEWS



**Crazy-quilt Los Angeles ballot** taxes ingenuity of voters, election officials and electronic designers. Norden's vote counter gives promise of earlier election returns at lower cost. Note timing marks printed on both sides of ballot for use with electronic counter.

## Computer Will Count Election Ballots

**A**N ELECTRONIC ballot counting system able to process 600 highly complex ballots per minute will be field tested by the County of Los Angeles during the coming presidential elections. Four such systems could handle election returns for all of Los Angeles' three million voters, while eliminating the 55,000 precinct workers who now tally the ballots.

The equipment, being developed by the Data Systems Dept. of the Norden Div. of United Aircraft, consists of a vacuum-operated ballot handler, an all-solid state data processor, a control console, and an output printer-punch.

Design features, required by the complexity of the ballots used in Los Angeles and by the obvious need to assure accuracy and prevent rigging include:

- Parity check for each ballot counted.
- Flexible, rapidly changeable programming by punched tape and plug board instructions.
- Automatic compensation for ballots

misaligned in passing through the ballot handler.

- Rejection of incorrectly marked ballots.
- Modular construction for rapid servicing in the event of breakdown.

### Ballots Marked in Fluorescent Ink

The ballot handler reads ballots of any length and up to 10 columns wide. Voters mark their ballot in fluorescent ink using a special, self-inking stamp. The ballot is read in the handler under ultra-violet light. Marks in each column are sensed by photomultipliers. Timing marks printed at each side of the ballot and read by photodiodes identify the top of each ballot and indicate where in each column the ballot is marked. The time interval between the sensing of timing marks at each side of the ballot indicates whether the ballot is tilted and to what degree. The timing information together with the output of the photomultipliers determine how the ballot is marked.

◀ CIRCLE 27 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

# ANY SWITCHING COMBINATION FROM SPST to TPDT

## with Centralab Switch Type Variable Resistors

CENTRALAB engineering took the conventional Model 2 composition variable resistor and developed these ingenious switching arrangements not available previously, with ratings up to 6 amps, 125 VAC. For use as single, dual concentric, or twin units, they are especially suitable for high fidelity and stereo, radio, television and phonograph applications. The use of these push-pull, push-push, and slide-switch units reduces the number of front panel controls, simplifies operation, and reduces component handling.



**Electronic ballot counting system** to be tested in Los Angeles. Ballots from each precinct are brought to centrally located unit for counting. Computer is programmed for each precinct by punched paper tape prepared in advance and read at the control console. System as shown may cost about 1/2 million dollars.

The data processor employs a high speed magnetic core memory consisting of 18 separate 10 x 60 core planes. Read and write times are approximately 6.6  $\mu$ sec each. Clock frequency is 300 kc. The associated logic and control circuits contain about 4,000 transistors and 4,000 diodes.

When a ballot is read, the marks are transferred to one memory plane which becomes an exact replica of the ballot. After the ballot is read, the contents of that plane are added to the votes already registered in a 12-plane array which stores the total votes cast for each candidate or issue within one election precinct, up to a maximum of 999 ballots. A binary coded decimal system is used.

### Machine Can Be Programmed for Various Ballot Formats

Each group of ballots cast by a precinct is counted separately by the machine. A plug board programs the machine for the number of columns in the ballot. Each batch of precinct votes fed into the machine is accompanied by a punched paper tape read at the control console which contains the positions of the candidates along each column. This is necessary because California law requires that the sequence in which candidates for the same office appear on the ballot be varied among precincts. Also, party and local elections can result in different ballot formats among precincts.

After the votes for a precinct are run through the ballot handler the contents of the memory are delivered on punched cards, tape, or electric typewriter.

Each data processor will be used with two ballot handlers, control consoles and printers. This will permit loading of one handler while the other handler is in operation. ■ ■



### SLIDE SWITCH SPECIFICATIONS

**Mounting Depth:** 2 1/2" from control surface, in any desired radial position for easy assembly of leads

**Switch:** Positive or spring return styles, 1/2, 1, 3 or 6 amp, SPST to TPDT, 125 VAC



### MODEL 2 VARIABLE RESISTOR SPECIFICATIONS

**Rating** 1/2 watt; **Size** 15/16" diam.  
**Resistances:** 200 ohms to 10 megohms, any taper



### PUSH-PULL, PUSH-PUSH SPECIFICATIONS

**Mounting Depth:** push-push: 3/32" from control surface  
push-pull: 1/16" from control surface

**Switch:** SPST, 3 amp, 125 VAC

Industrial quantities of push-pull and push-push types available for immediate delivery at factory prices from your near-by CENTRALAB industrial distributor.

# Centralab

B-6040 ®

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

SEE US AT WESCON BOOTH 664  
CIRCLE 28 ON READER-SERVICE CARD

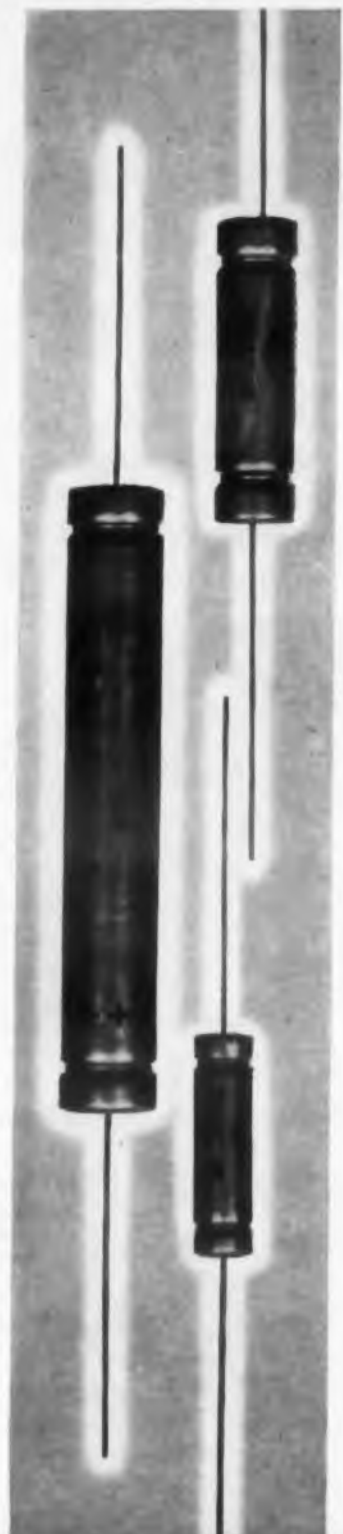
The Electronics Division of Globe-Union Inc.  
960H East Keefe Avenue • Milwaukee 1, Wisconsin  
Centralab Canada Limited • Ajax, Ontario



# NEW

## General Electric High-voltage Tantalytic\* Capacitors

# RATINGS TO 300 VOLTS



General Electric announces a new high-voltage foil Tantalytic capacitor—rated to 300 volts at 85C and to 250 volts at 125C—in both polar and non-polar designs.

**SMALLER IN SIZE** than any previously available capacitor with similar voltage ratings, these new General Electric capacitors also provide size advantages over series arrangements of lower voltage units.

**GREATER CAPACITANCE STABILITY**, achieved over the entire temperature range, is provided by these new high-voltage Tantalytic capacitors. An 8 percent maximum capacitance increase at high temperatures and a 20 percent maximum capacitance loss at -55C are specified.

**CLOSER CAPACITANCE TOLERANCE** of  $\pm 15$  percent is standard. This represents a significant improvement over the  $\pm 20$  percent or -15 +75 percent initial tolerances characteristic of lower voltage capacitors.

**SUPERIOR LIFE PERFORMANCE** during 2000 hours under maximum rated conditions is realized, with a maximum capacitance change not exceeding 10 percent.

**FOR COMPLETE INFORMATION** on this significant breakthrough in Tantalytic capacitor design, contact your General Electric Sales Representative, or write Section 449-15, General Electric Co., Schenectady 5, N. Y.

\*Registered trademark of General Electric Co.

TYPICAL OF THE WIDE RANGE OF RATINGS AVAILABLE WITH THE NEW G-E HIGH-VOLTAGE FOIL TANTALYTIC CAPACITORS

Cat. No.	Volts	Temp.	Capacitance (uf)	Polarity	Max. Leakage at Rated Temp. (ua)	Max. Imp. -55C 120 CPS (Ohms)	Diam.	Length
29F2200	200	85C	0.35	P	32	5715	$\frac{3}{16}$ "	$\frac{1}{16}$ "
29F2105	300	85C	25.0	P	500	82	$\frac{1}{2}$ "	$2\frac{3}{4}$ "
29F2108	300	85C	2.0	NP	150	1010	$\frac{3}{8}$ "	$2\frac{1}{8}$ "
29F2207	200	85C	0.15	NP	32	13330	$\frac{3}{16}$ "	$\frac{1}{16}$ "
29F2161	250	125C	2.5	P	100	830	$\frac{3}{8}$ "	$1\frac{1}{16}$ "
29F2164	250	125C	13.0	P	325	160	$\frac{1}{2}$ "	$2\frac{3}{4}$ "

These units are supplied in tubular form, in lightweight aluminum cases, with axial leads, and are available with insulating sleeve in 7 case sizes.

# GENERAL ELECTRIC

CIRCLE 29 ON READER-SERVICE CARD

## NEWS

### Telex Random-Access Disk File Reduces Access Time One-Third

A new, random-access, disk memory has nearly a third the access time and double the storage capacity of currently available disk filer.

The improvement in access time is due to the use of two sets of read-record heads for each of 16 stacked disks. Competitive units have used a single set for a stack of 50 disks.

The new unit, Telex I, was developed by Telex Inc., Minneapolis. Its average access time was said to be 150 msec (with a 250 msec maximum), that of competitive units is 425 msec average, and 800 msec maximum.

Telex I has a capacity of 20 to 22 million, 7-bit characters per stack of disks. Competitive units have capacities of 10 million characters per stack.

The increased capacity is due primarily to the larger diameter of the Telex disks—31 in. compared to the conventional 24 in. Data are recorded on Telex with a density of 400 bits per inch of recording track.

As with the competitive model, the Telex disks are mounted on a vertical shaft driven by a motor at 1,200 rpm. On the Telex unit, however, two heads, mounted about 5 in. apart on rigid arms, skim over each surface of each disk. On competitive units, a single pair of read-record heads are moved, in operation, from disk to disk.

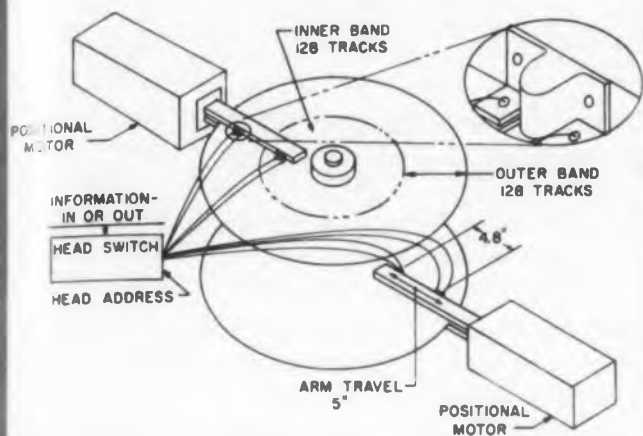
The arms of Telex I move radially across a disk as it rotates. This radial movement is determined by motors, (one for each disk), whose field coils are excited by digital commands.

Each disk has 256 concentric recording tracks in inner and outer bands of 128 tracks each. Because each surface has two heads—one for each



Telex I disk memory has four read-record heads and a head-positioning motor for each disk.

ELECTRONIC DESIGN • August 17, 1960



Two read-record heads skim over each surface of each disk. Each head covers a 5 in. band of 128 recording tracks.

band—the motor need move the arm through only 128 positions.

Telex I is scheduled for production early next year. The company also intends to market a larger and faster version of Telex I in the latter half of next year. This unit, Telex II, will have 64 disks with a capacity of about 88-million characters, and an average access time of 125 msec.

Telex I will be priced between \$50,000 and \$90,000; Telex II will cost less than \$100,000.

### Experimental UHF TV Stations Planned For New York City

New York City has gained approval of a \$2 million item in the Federal Communications Commission budget to build two ultra-high-frequency TV stations.

The station will be an experiment to test the adequacy of and the problems surrounding the increased use of uhf channels.

The Federal Government has proposed the station here so that it can thoroughly explore uhf under adverse conditions—a metropolitan area filled with tall buildings. The feasibility of uhf in an area saturated by vhf sets would also be studied.

Among the factors to be evaluated and developed are signal strength at the various locations' reception compared with vhf reception at the same points; and different types of uhf receivers, with the most practical to be sought.

Some experiments will be conducted with circularly polarized radiated signals; with multiple transmissions of the same program on different frequencies from different locations, and with receivers having differing noise sensitivities.

Depending upon the results of the experiment, the FCC believes that a nationwide uhf service would be possible or at least the intermixing of vhf and uhf stations. Improvements in uhf transmission could lead to a shift of all commercial TV to uhf including those stations now in operation.

# Want the facts?

**E**lementary, my dear fellow! The design of Borg 205 Series Micropots provides one of the most reliable precision potentiometers ever produced. Originally designed for the military, the 205 is now extremely successful in many commercial applications. Linearity accuracy . . .  $\pm 0.1\%$  to  $\pm 0.05\%$ , independent or zero-based.

Total resistance . . . 1.15 to 100,000 ohms. Meets

- full range of military specifications . . . vibration, shock, humidity, temperature, salt spray, altitude, fungus and acceleration. Your Borg technical representative or distributor has complete information.

Ask for data sheet BED-A131.

*Borg Equipment Division,  
Amphenol-Borg Electronics Corporation,  
Janesville, Wisconsin. Phone Pleasant 4-6616.*



Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards.  
CIRCLE 30 ON READER-SERVICE CARD



ONE OF MANY EXAMPLES  
OF EXCELLENCE IN THE DATA  
HANDLING FIELD

Cook Electric Company's  
*New*  
**DIGITAL TAPE  
TRANSPORT**



**SOLID STATE  
ULTRA RELIABLE  
HIGH PERFORMANCE  
MILITARY QUALITY**



The Data-Stor Model 59 Digital Tape Transport is ideally suited for use in computer, instrumentation and control applications. It incorporates the highly reliable features of military tape transports developed by Cook Electric Company during the past 12 years, and has been proven in the Atlas, Titan, Polaris and other missile programs.

These features include exclusive use of modern ultra reliable solid state circuitry, eliminating gas or vac-

uum tubes. Precise tape handling is insured by proportional reel drive servo systems that have no jerky step servos. Tension error sensing is accomplished by synchro transmitters with no unreliable potentiometers or contact pile-ups. Field adjustments are eliminated by building tolerances into a single rugged tape deck casting. Endurance and quality are assured by strict adherence to the exacting design and workmanship requirements of MIL-E-4158.

**TAPE SPEEDS TO 150 IPS • LESS THAN 3 MS STOP/START • REWIND SPEEDS TO 400 IPS • NO PROGRAMMING RESTRICTIONS • PACKING DENSITIES TO 600 NRZ BPI • OPERATES FROM 5 VOLT CONTROL PULSES OR LEVELS OF EITHER POLARITY • FRONT PANEL ACCESS • CHOICE OF NARTB, IBM, OR SPECIAL REELS • ANY TAPE TO 1" • CONDUCTIVE LEADER, LIGHT TRANSMISSIVE, OR LIGHT REFLECTIVE END OF TAPE SENSORS • SOLID STATE READ/WRITE AMPLIFIERS • METAL FACED READ/WRITE MAGNETIC HEADS • AVAILABLE AS HIGH SPEED PHOTOELECTRIC READER.**

Experienced recording systems engineers are invited to apply for existing employment opportunities.

*Data-stor*  
A DIVISION OF  
Cook Electric Company

Designers and makers of ground and airborne magnetic recording systems, photoelectric readers and computer peripheral equipments.

ADDRESS YOUR INQUIRIES TO  
8100 MONTICELLO AVENUE SKOKIE, ILLINOIS  
CIRCLE 31 ON READER-SERVICE CARD

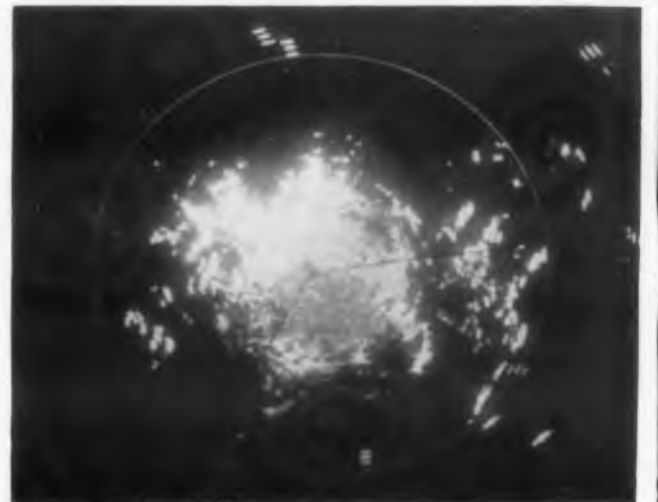
## NEWS

### New Moving Target Indicator Adaptable to Most Radars

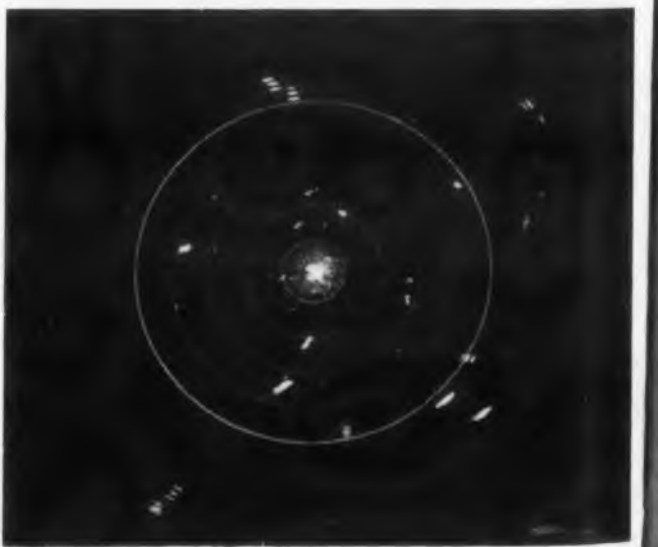
A simplified radar moving-target indicator system was recently demonstrated by Intercontinental Electronics Corp. of Mineola, N.Y. The system employs two storage tubes in cascade as comparison memory gates to eliminate fixed or slow-moving targets.

According to the company, the INTEC MA-372 dual canceller, is adaptable to most existing radar sets and in many cases can be substituted directly without the need for any modifications.

The INTEC MA-372 canceller employs two INTEC Model TCM-13X storage tubes as memory devices in place of the delay lines generally used in other canceller systems. Within these tubes, an unmodulated spiral sweep is traced on the storage membrane during each pulse repetition period. During the same period, video information is delivered to the conductive backplate of the target membrane.



PPI scope presentation before switch-on of Intercontinental Electronic Corp.'s MA-372 dynamic dual canceller for moving target indication.



Clearer definition and sharper contrast of moving targets is shown in PPI scope presentation after switch-on of INTEC's new system.

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For fixed targets, an equilibrium condition exists, and there is no output from the tube. Moving targets upset this equilibrium, and an output, in the form of a change in collector current, appears. This change in current gates the signal, which represents the moving target. A cancellation ratio of 40 db is achieved.

A comparison of three pulse periods is employed in discriminating against stationary targets. The equipment includes its own coherent oscillator, 30-mc if limiter, MTI variable range gate with range mark, and trigger generator. Coherent oscillator lock pulse and frequency stabilized if signals are required, and normal video and external trigger are optional.

### Wide-Range Radar Tracker Under Development at Bendix

An electronic tracking device which can follow space craft and aircraft simultaneously is under development by Bendix Corp.'s Radio Div. in Towson, Md.

The company has signed a \$4 million contract to build a five-story demonstration model which will be used both to track missiles from Wallops Island, Va., and to monitor air traffic in the Baltimore-Washington flight area. The contract was let by the Air Force and the Advanced Research Projects Agency.

The model is called Electronically Steerable Array Radar (ESAR) and can focus its radar on one object at a time while keeping other vehicles in view. This ability is made possible, Bendix says, through the development of a system using multiple electronic track and search beams without the need of moving parts such as those which are used for the mechanical rotation of a conventional antenna.

### Airborne Radar Shows Moving Targets



Side-looking radar to display moving targets has been developed by Motorola Inc.'s Military Electronics Div. under an Army Signal Corps contract. The AN/APS-85 system is carried aboard this RL23D, with antenna slung underneath. Strips of terrain 20 miles wide are mapped on each side of the aircraft.

## V-BAND MAGNETRONS



Life — over 700 hours reported

Peak power available — more than 10 kw.

(More power than you can get from any other device at this frequency)

Duty cycle — up to 0.001. (For the BL-221, it is 0.00055)

Vibration — will survive 10 g's

Shock — 50 g's at 4 millisecc

Lightweight — 7.25 lbs

Mounting — mates to modified standard flange

Ruggedized — Ceramic and metal construction

Fixed tuned

Model	Tube Type	Frequency Range (MC)	Minimum Peak Power (KW)	Output Mates with
V	BL-235	51,000-54,000	10	UG385/U
V	BL-236	54,080-57,000	10	UG385/U
V	BL-237	57,000-60,000	10	UG385/U
V	BL-221	69,000-70,500	10	UG385, U



**BOMAC laboratories, inc.**

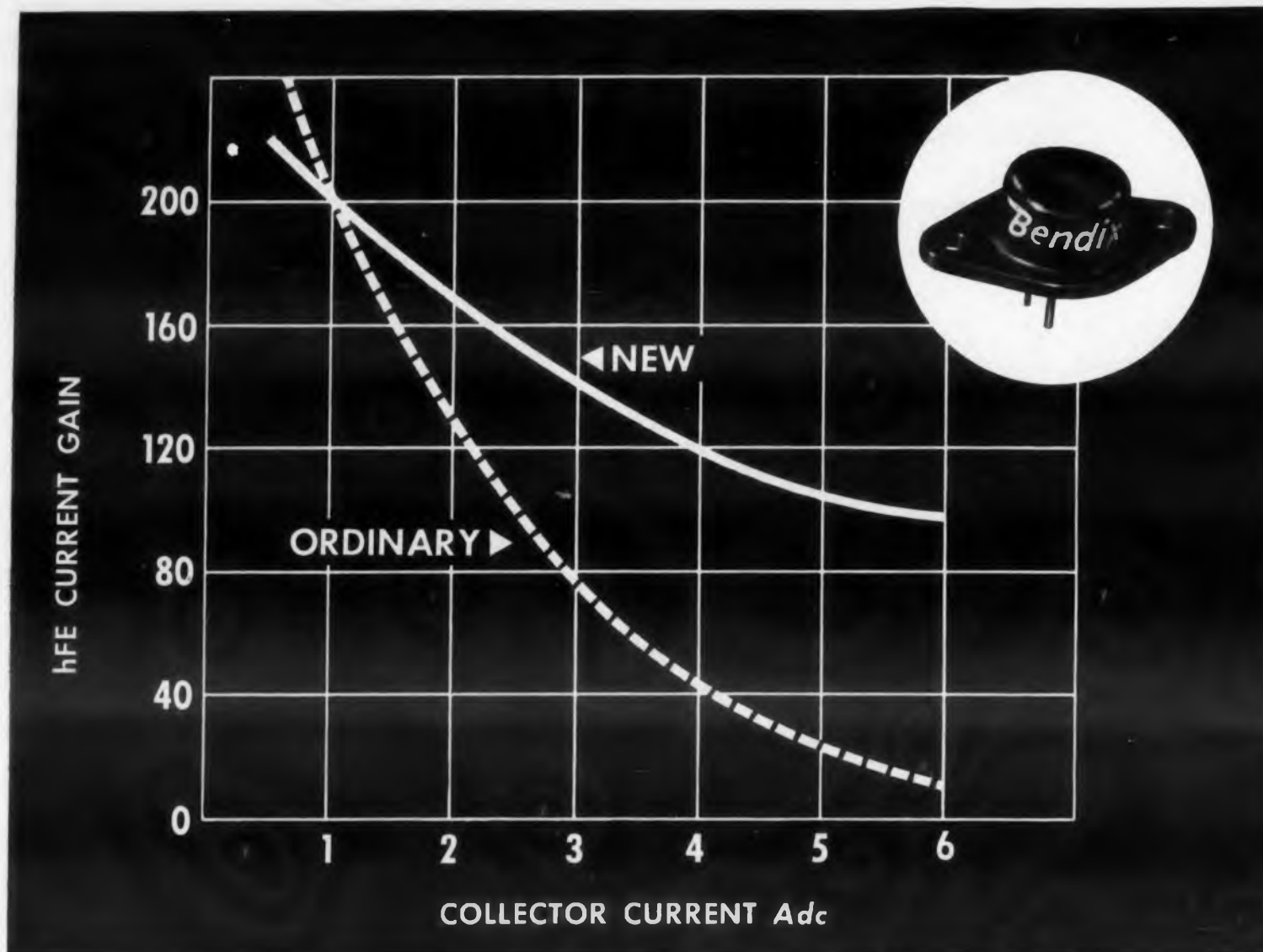
SALEM ROAD • BEVERLY, MASSACHUSETTS

Offices in major cities — a subsidiary of Varian Associates

Leaders in the design, development and manufacture of V-BAND, UHF, SHF, X-BAND, K-BAND, reference cavities, crystal oscillators, wave guides, modulators, klystrons, vacuum tubes, pressurizing windows, metal wave tubes, high frequency multi resonant, surge protection.

CIRCLE 32 ON READER-SERVICE CARD





Solid line indicates the low beta fall-off of one of the new Bendix transistors as compared to that of an ordinary transistor.

## NEW BENDIX HIGH GAIN INDUSTRIAL POWER TRANSISTORS OFFER FLATTEST BETA CURVE

Now available—a new series of power transistors with the flattest beta curve in the industry, made possible by an exclusive Bendix process. This new series has very high current gains—up to 200 at 3 Adc—and a 10-ampere peak current rating.

Featuring ten-amp performance at a five-amp price, the 2N1136, A, B; 2N1137, A, B; and 2N1138, A, B series provide:

LOW BETA FALL-OFF → LESS DRIVE AND LESS DISTORTION  
 LOW SATURATION RESISTANCE → GREATER CIRCUIT EFFICIENCY  
 VOLTAGE BREAKDOWN RATINGS → ELIMINATION OF BURN-OUT  
 CURRENT GAIN MATCHING → OPTIMUM CIRCUIT PERFORMANCE

Ideally suited for use in static converters and regulators, these power transistors also have numerous applications in relay replacements and drivers for relays, magnetic clutches, solenoids and other loads requiring high current. In addition, their extremely high current gain and excellent hFE linearity make them practical and efficient television vertical output amplifiers and hi-fi amplifiers.

Current Gain hFE at $I_c = 3 A_{dc}$	Maximum Voltage Rating		
	Vcb 60 Vce 40	Vcb 90 Vce 70	Vcb 100 Vce 80
50-100	2N1136	2N1136A	2N1136B
75-150	2N1137	2N1137A	2N1137B
100-200	2N1138	2N1138A	2N1138B

For complete information, contact SEMICONDUCTOR PRODUCTS, THE BENDIX CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office.

West Coast Sales Office: 117 E. Providencia Avenue, Burbank, California  
 Midwest Sales Office: 4104 N. Harlem Avenue, Chicago 34, Illinois  
 New England Sales Office: 4 Lloyd Road, Tewksbury, Massachusetts

Export Sales Office:  
 Bendix International Division, 205 E. 42nd Street, New York 17, New York

Canadian Affiliate:  
 Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario, Canada

SEMICONDUCTOR PRODUCTS  
**Red Bank Division**  
 LONG BRANCH, N. J.



CIRCLE 33 ON READER-SERVICE CARD

## NEWS

### GE Announces New Computer; Unit Has 16,000-Word Memory

General Electric has entered the business computer field with the announcement of its GE-225 medium-sized information-processing system. The new computer is all-transistorized and will rent in the \$4,000-\$12,000 per month range depending on peripheral equipment.

Design features include a magnetic-core memory expandable to 16,384 20-bit binary words, supplemented by auxiliary magnetic-drum storage of equal capacity. Processing times, including access to the core memory, are 40  $\mu$ sec for addition or logic, 250  $\mu$ sec for multiplication and 500  $\mu$ sec for division. Access time to the drum averages 8.3 msec. All conventional input-output devices can be mated to the computer including punched cards, punched tape, magnetic tape and printer.

In a quiet sales campaign over the past six months two dozen orders have been landed for the GE-225. Initial deliveries are expected late this year and new orders are being accepted on 18 months delivery.



First General Electric business computer is assembled at the company's computer department in Phoenix, Ariz. Some 400 plug-in logic boards of the type shown here are used in the machine which also includes over 3,000 transistors.

### Improved Phone Engineering Seen Through Use of Computers

Increased use of computers will make telephone engineering faster, cheaper, and more accurate than is possible today, a symposium at the summer meeting of the AIEE was told in a paper by three engineers.

Computers would also free engineers "from many tedious tasks," the paper said. Authors of the paper were L. W. Blumer, Northwest Bell

Telephone Co., Omaha, Neb.; N. E. List, Michigan Bell Telephone Co., Detroit; and G. E. Reifenstuhl, Western Electric Co., Chicago.

"Costs of engineering should be reduced or held in check. Over-all intervals will decrease. Accuracy will improve. Resulting standardization will be responsible for further savings. 'By-products,' such as cost data, accounting information, power-drain data, etc., may be even more valuable than the tangible advantages seen today," the paper said.

### Computer Use Widens In Warfare Simulation

Battles inside of a computer are taking the place of the real thing in training the West's armed forces.

Some 6,000 Allied officers in a recent training exercise at Fort Lee, Va., simulated a problem in supplying widely dispersed units over a Western European nuclear and chemical-warfare battlefield.

The operation, designated LOGEX 60, was accomplished by linking an IBM 650 computer at Fort Monmouth, N. J., to Fort Lee. The computer represented 31 field computers at various depots and central stock-control points over the simulated attack area.

### IBM 7070 to Industry



First all-transistorized data processing system delivered to private industry—an IBM 7070—gets final checkout before delivery to Texas Instruments. Magnetic cores store up to 100,000 digits with 6- $\mu$ sec access time. Magnetic discs store an additional 48 million digits with 850- $\mu$ sec access time. Internal processing speeds are 16,000 5-digit additions, 860 10-digit multiplications or 320 10-digit divisions per second. Entire system consists of 22 units with a total weight of 17 tons. Forty-one thousand transistors are used. IBM officials claim to have received 300 orders for 7070 systems and expect to deliver 55 of them this year. The system installed at TI is leasing for \$31,000 monthly.

# Tung-Sol high power germanium transistors

2N174, 2N174A, 2N173, 2N278, 2N277, 2N443, 2N442, 2N441, TS748\*

This full and select complement of Tung-Sol high power transistors offers many distinct advantages over similar competitive types.

- ▶ Exclusive design features combine with Tung-Sol's pace-setting quality assurance practices to assure designers unexcelled operational reliability.
- ▶ Wide interchangeability lets you specify these pnp transistors for most industrial and military uses. Typical applications include high power amplifiers, DC-to-DC converters, DC-to-AC inverters, regulated power supplies, motor controls, servo amplifiers, relay drivers, switching circuits, etc.
- ▶ Every transistor in this versatile series produces highly efficient power transfer and audio amplification.

- ▶ They feature the vacuum-tight, all copper "Cold Weld" package—a Tung-Sol "first" in this transistor class—for broader design flexibility and long-life reliability.
- ▶ They are manufactured in the industry-preferred JEDEC-TO-36 case. This stud-mounted single-end construction with solid-lug terminals simplifies installation and facilitates efficient heat-sink design.
- ▶ They are subjected to rigid military environmental tests and radioactive gas leak detection tests to further assure maximum reliability.

Write for full technical details. Tung-Sol Electric Inc., Newark 4, New Jersey.

Absolute Maximum Ratings @ 25°C	2N174A	2N174	2N173	2N443	2N278	2N442	2N277	2N441	
Collector Voltage $BV_{CB}$ ( $V_{EB} = +1.5v$ )	80	80	60	60	50	50	40	40	Volts
Collector Voltage $BV_{CES}$ ( $I_c = 0.3A$ )	70	70	50	50	45	45	40	40	Volts
Emitter Voltage $BV_{EBO}$	60	60	40	40	30	30	20	20	Volts
Collector Current $I_c$	15	15	15	15	15	15	15	15	Amp
Junction Temperature $T_j$	-55 to +95	-55 to +95	-55 to +95	-55 to +95	-55 to +95	-55 to +95	-55 to +95	-55 to +95	°C

...deliver  
up to  
15 amperes



\*The TS748 is specially designed to meet the requirements of MIL-T-19500/13A and is supplied with flexible leads.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N.J.; Melrose Park, Ill.; Newark, N.J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ontario.

CIRCLE 34 ON READER-SERVICE CARD

 **TUNG-SOL**





## WHICH JOB WOULD YOU TAKE?

If you're like most of us, you'd take the job with the more tempting salary and the brighter future.

Many college teachers are faced with this kind of decision year after year. In fact, many of them are virtually bombarded with tempting offers from business and industry. And each year many of them, dedicated but discouraged, leave the campus for jobs that pay fair, competitive salaries.

*Can you blame them?*

These men are not opportunists. Most of them would do anything in their power to continue to teach. But with families to feed and clothe and educate, they just can't make a go of it. They are virtually

forced into better paying fields.

In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

At the rate we are going, we will soon have a very real crisis on our hands.

We *must* reverse this disastrous trend. You can help. Support the college of your choice today. Help it to expand its facilities and to pay teachers the salaries they deserve. Our whole future as a nation may depend on it.

It's important for you to know more about what the impending college crisis means to you. Write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, N.Y.

Sponsored as a public service,  
in co-operation with the Council for Financial Aid to Education



## NEWS

### Test Chamber 'Flies' Parts



Test chamber "flies" parts for space missiles and jet aircraft to simulated 1,000,000-ft altitude at Itemlab Inc., Port Washington, N.Y. Test Parts are sealed in a vacuum behind a door ordinarily used to "cap" industrial pressure vessels and pipelines. Research tests are conducted in extremely combustible high-temperature gas-air mixtures to learn if operation of electronic or electro-mechanical components might spark explosions in flight.

### Piezoelectric Qualities Cited For Zinc Oxide, Cadmium Sulfide

Recent experiments have disclosed a high degree of piezoelectricity; for zinc oxide and cadmium sulfide, according to Dr. A. R. Hutson of Bell Telephone Laboratories, New York City.

The degree of piezoelectricity exhibited by lithium-doped zinc oxide is said to be about four times as great as that of quartz, while that of cadmium sulfide is twice as great. Confirming measurements were made on single crystals of zinc oxide grown both by vapor techniques and from a flux. The cadmium sulfide crystals were vapor grown.

Dr. Hutson decided to investigate piezoelectric constants of the materials while studying some of their unusual conductivity properties.

The excess conductivity of the zinc oxide was quenched by diffusing lithium atoms into the material. When this was done, the resistivity of the compound was raised from  $10^3$  to  $10^{12}$  ohms per cm at room temperature.

Dr. Hutson calculated electromechanical coupling coefficients to be about 0.4 for zinc oxide and 0.2 for cadmium sulfide, compared with 0.095 for quartz.

## Phosphorous-Diffusion Method Used for Making Solar Cells

A new phosphorous-diffusion technique for producing silicon solar cells has been developed by the U. S. Army Signal Corps Research and Development Laboratories, Ft. Monmouth, N. J.

The technique promises better reproductibility and does not seem to be as destructive on semiconductor surfaces as conventional methods. Efficiencies in the 12-per-cent range have been obtained consistently, and researchers hope for higher efficiencies with further development. Another 1 per cent is added by properly coating the cells.

The technique substitutes electrons for holes in the active surface area, so that higher injection efficiencies are achieved.

The Russians have been using a phosphorous-diffusion process to produce solar cells, according to a Signal Corps spokesman, but the reasons for this were not apparent until the new processing technique was developed.

In conventional solar-cell production, boron is normally diffused onto an n-type silicon ingot, to produce a p-type skin. Antimony, arsenic, or some other suitable dopant is used to produce the n ingot.

TA boron-doped p-type silicon ingot is used in the new Signal Corps process. Phosphorous is diffused onto the surface to produce an n layer.

The Signal Corps plans a meeting soon with interested companies to describe details of the new process.

## EE Professor at Northwestern Applies Electronic Theory to Business

Gordon J. Murphy, professor of electrical and industrial engineering at Northwestern University, has won a one-year grant from the Foundation for Instrumentation Education and Research to apply feedback control theory to production and inventory-control problems.

Mr. Murphy will attempt to establish guides to minimize costs by employing the sampled-data theory, with the mathematical tool being the Z-transformation. This is a special form of the Laplace transformation, a concept used extensively in feedback-control theory in recent years.

The \$5,000 grant is for one year. FIER, a 12-year-old organization, has members from both industry and education and is interested in measurement, information handling, computation, and automation. In establishing such grants and graduate fellowships, FIER hopes to inject "feedback" into an industry which has grown from pre-war modest size into a \$6 billion giant today.



**CORNING GLASS RESISTORS**  
...in your hands as quickly as **123**

When you're faced with a rush job that requires high stability resistors, do this:

1. Specify the components from Corning's complete line of glass resistors;
2. Call your local Corning distributor and tell him what you need;
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This Corning fusion-sealed glass resistor defies all environmental conditions . . . heat, moisture, vibration. See for yourself. Boil it in water as shown here. Bounce it. Drop it. It's practically indestructible.



CIRCLE 36 ON READER-SERVICE CARD



## STOCK SHIPMENT PROGRAM

### 26 VOLT FIXED WINDING AND GENERATOR OUTPUT

FRAME SIZE	MOTOR OR GENERATOR	FREQUENCY CYCLES	POLES	CONTROL WINDING	PART NUMBER	
					PLAIN SHAFT 1/2" x .1200"	HOBBED SHAFT 13T x 120P
8	M	400	6	26S	8M61A	8M61B
8	M	400	6	33CT	8M62A	8M62B
8	MG	400	6	26S	8MG61A	8MG61B
8	MG	400	6	33CT	8MG62A	8MG62B
9	M	400	4	26P	9M40A	9M40B
9	M	400	4	26S	9M41A	9M41B
9	M	400	4	26S	9M61A	9M61B
9	MG	400	4	26S	9MG41A	9MG41B
9	MG	400	6	26S	9MG61A	9MG61B

### 115 VOLT FIXED WINDING AND GENERATOR OUTPUT

FRAME SIZE	MOTOR OR GENERATOR	FREQUENCY CYCLES	POLES	CONTROL WINDING	PART NUMBER	
					PLAIN SHAFT 1/2" x .1200"	HOBBED SHAFT 13T x 120P
11	M	60	2	115CT	11M25A	11M25B
11	M	60	2	115P	11M24A	11M24B
11	M	400	6	115S	11M65A	11M65B
11	M	400	6	36CT	11M63A	11M63B
11	MG	400	6	115S	11MG66A	11MG66B
11	MG	400	6	36CT	11MG63A	11MG63B

FRAME SIZE	MOTOR OR GENERATOR	FREQUENCY CYCLES	POLES	CONTROL WINDING	PART NUMBER	
					PLAIN SHAFT 5/8" x .1870"	HOBBED SHAFT 15T x 96P
15	M	60	2	230S	15M27C	15M27D
15	M	400	4	115S	15M46C	15M46D
15	M	400	4	36CT	15M43C	15M43D
15	M	400	8	115S	15M86C	15M86D
15	M	400	8	36CT	15M83C	15M83D
15	MG	60	2	230S	15MG27C	15MG27D
15	MG	400	4	115S	15MG46C	15MG46D
15	MG	400	4	36CT	15MG43C	15MG43D
15	MG	400	8	115S	15MG86C	15MG86D
15	MG	400	8	36CT	15MG83C	15MG83D
18	M	60	2	280S	18M28C	18M28D
18	M	400	4	115S	18M46C	18M46D
18	M	400	4	36CT	18M43C	18M43D
18	M	400	8	115S	18M86C	18M86D
18	M	400	8	36CT	18M83C	18M83D
18	MG	60	2	280S	18MG28C	18MG28D
18	MG	400	4	115S	18MG46C	18MG46D
18	MG	400	4	36CT	18MG43C	18MG43D
18	MG	400	8	115S	18MG86C	18MG86D
18	MG	400	8	36CT	18MG83C	18MG83D

Key to Symbols—P: Straight Winding (2 leads) S: Split Winding (4 leads) CT: Center Tapped Winding (3 leads)

**SPECIFICATIONS:** ROTORS—8 through 11 1/2 inch 15 through 18  
shaft extension 1/2 inch 0.120 inch 13 T 96 P  
plain shaft O.D. 0.120 inch 13 T 96 P  
hobbed shaft teeth 120 P  
hobbed shaft pitch 120 P

**BEARINGS**—EB lubrication; **LEADS**—8" minimum; **DELIVERY**—shipped five working days from receipt of order; **QUANTITY**—presently limited to five units, subject to change. Part numbers do not appear on decals.

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Transicoil Division exercises complete control over every stage of servo manufacture, turning wire, strip, and bar stock into complex servo assemblies. Only this kind of manufacturing control can assure you top performance . . . even on fast delivery prototype models.



#### TECHNOLOGY

Transicoil Division engineers have been in the forefront of innumerable advances in servo art. Take miniaturization . . . Transicoil introduced plate-to-plate winding, eliminating the transformer from servo amplifier design . . . developed the size 8 and size 5 motors and motor generators.



#### FACILITIES

Given the desire to turn out reliable equipment, you still need the facilities to bring your wishes to reality. Transicoil Division backs up its aims with complete testing facilities, and one of the toughest, most rigid testing programs developed for servos.

## NEWS

### IBM 650 Computer Employed To Simulate Bank Management

Three new "banks" appeared in Pittsburgh for a day when a group of Mellon National Bank and Trust Co. officers divorced themselves from a day's regular activities to participate in a new technique called "Bank Management Simulation."

By using a computer, it is possible in the simulation to condense two years' operations into a single day. The Mellon Bank's participation marked the first time the technique has been used in a bank and it now opens new vistas for electronic data-processing equipment and for bank management.

Servo motors and motor-generators listed here are on the shelf now. One week after your order's been received they'll be inspected and on their way to you. Ideal for fast prototype requirements, these stocked units—"at regular factory prices"—are precisely the same fine servomechanisms for which Daystrom's Transicoil Division is known. As a result you can count on future large quantity production units to duplicate the performance characteristics of the prototypes in every respect. To place orders, write, phone, or wire STOCKSHIP, Daystrom Incorporated, Transicoil Division, Worcester, Montgomery County, Pa.

The Mellon Bank's IBM 650 Computer was fed management "solutions" to everyday bank problems and the computer responded with new conditions. As a result, three teams of three bank officers each were able to experience several years of banking decisions, and see the results, in a period of just one day.

The idea stems from the military where simulated war games have been used for years to help in the training of officers.

### Precision Pot Manufacturers Establish A New Committee

An organizational meeting of manufacturers of precision potentiometers was held in June at Radio Corp. of America in Camden, N.J.

Representatives from fifteen of the leading manufacturers met to discuss their mutual problems in the face of greater emphasis on reliability of electronic component parts.

The objectives of the new group will be the promotion of greater standardization of design types and parameters, test methods, nomenclature and joint educational efforts.

D. McNeely of Helipot-Beckman was elected general chairman of a committee to draft a constitution and by-laws. East and West Coast chairmen were selected to expedite its formulation. Precision potentiometer manufacturers interested in this group are invited to contact Mr. McNeely at 2500 Fullerton Road, Fullerton, Calif.

### Bendix Transistor 'Brake' To Control Chain Reaction

A transistorized "electronic brake" under development for the Atomic Energy Commission will control chain reaction at the AEC's new Pathfinder Atomic Power Plant at Sioux Falls, S.D.

Bendix Corp.'s Cincinnati division said the unit, called a "reactor-flux monitor and safety system," will automatically and continuously measure the

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CIRCLE 37 ON READER-SERVICE CARD

# Widest Option in Low-Power Rotary Switches

number of neutrons put out by the reactor from the start of its chain reaction through the full operational cycle. Whenever the energy output exceeds normal levels, the system will automatically shut down the reactor in a fraction of a second, the engineers said.

Not only the amount of energy output, but also the rapidity with which it is being built up at any time, are sensed by this system, and if the reactor's human supervisors do not take indicated control methods when too-rapid build-up is taking place, the system automatically shuts it down. It literally feels the pulse of a nuclear reaction, Bendix engineers said, by measuring neutrons, emitted in the reaction.

The Pioneer Service and Engineering Co., Chicago, the architect-engineering firm that designed the Pathfinder plant, placed the order with Bendix.

## Six Companies to Tour Instruments For Operation from DC to 220 Kmc

Six leading manufacturers of electronic equipment have joined forces for the sole purpose of producing a technical road show. At five key sites within 90 miles of New York City, they will show instruments for operation from dc to 220 kmc.

Starting at the low-frequency end of the spectrum, the show sponsors are:

Lambda Electronics Corp., which manufactures dc power supplies;

Sensitive Research Instrument Corp., which offers dc and low-audio-frequency standards as well as instruments whose accuracy falls off to 0.5 per cent at 10 mc;

Tektronix Inc., which has a line of oscilloscopes for use from dc to 1 kmc;

General Radio Co., whose line of more than 350 items covers dc to 5 kmc;

Panoramic Radio Products Co. Inc., whose automatic measurement instruments and spectrum analyzers cover 1/2 cps to 44 kmc;

FXR, Inc., whose principal instruments cover 400 mc to 220 kmc.

The door-to-door instrument show, manned by engineers and aimed at engineers, will be open from 1 to 9 p.m. at:

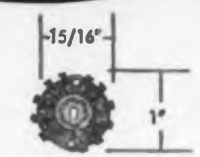
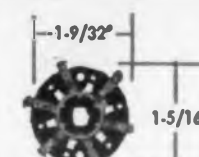
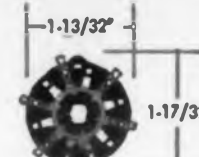
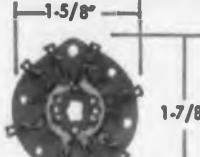
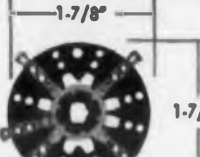
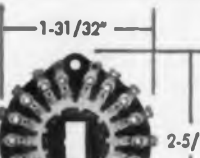
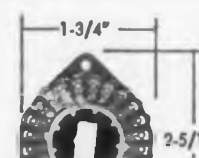
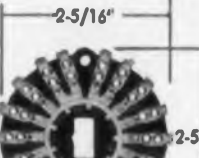
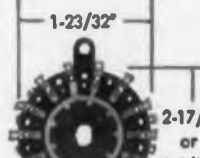
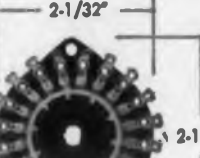
The Sagamore Room of Roosevelt Field Shopping Center in Garden City, L.I., on Oct. 5-6;

The Treadway Inn in Norwalk, Conn., on Oct. 11;

The Nelson House in Poughkeepsie, N.Y., on Oct. 13;

The Meadowbrook in Cedar Grove, N.J., on Oct. 17;

The Cherry Hill Inn in Moorestown, N.J., on Oct. 19-20.

 <p>THROW: 30°, 36°, 45° INSULATION: stator glass silicone; rotor, KEL-F</p>	 <p>THROW: 30°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>THROW: 25.7°, 30°, 36°, 45°, 60° INSULATION: phenolic, ceramic</p>	 <p>THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>THROW: 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>
 <p>THROW: 20°, 40° INSULATION: phenolic</p>	 <p>THROW: 15°, 30° INSULATION: phenolic</p>	 <p>THROW: 20°, 40° INSULATION: phenolic, Mycalex</p>	 <p>THROW: 12.85°, 25.7° INSULATION: phenolic</p>	 <p>THROW: 12.85°, 18°, 25.7°, 36° INSULATION: phenolic</p>


**METAL PARTS AND FINISHES**

**STANDARD COMMERCIAL**—Punched steel parts are lead-coated, cold-rolled steel. Parts such as nuts, lockwashers, etc., are cadmium-plated steel. Shafts may be cadmium-plated steel, brass, or aluminum. Brass parts are unplated.

**TROPICAL OR 50-HOUR SALT SPRAY MILITARY SPECIFICATIONS**—All steel and brass parts are cadmium-plated and chromate-dipped. Stainless steel parts are passivated.

**200-HOUR SALT SPRAY MILITARY SPECIFICATIONS**—All brass parts are nickel plated. All stainless steel parts are passivated. Shafts, "C" washers and index springs, balls and plates are stainless steel.

**CONTACTS**



**Famous Oak double wiping, high-pressure design. Riveted or eye-letted in place and keyed from turning. Rotors shorting or nonshorting.**

**TYPE 1**—Contacts are spring brass, silver-plated. Rotors are brass, silver-plated. Temperature limit: 100°C constant ambient.


**TYPE 2**—Contacts, spring tempered-silver alloy. Rotors, coin-silver alloy. Temperature limit: 100°C constant ambient.

**TYPE 3**—Contacts and rotor blades made of Oak alloy

**CMS-202**. This is a special alloy for high temperature operation to 150°C.

**GOLD-PLATED CONTACTS**—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash.

**FOR PRINTED CIRCUITS**—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for die soldering.



**AC SNAP SWITCHES**—36 models for use on most switch types. All are UL approved.

**POTENTIOMETERS**—Customers' choice. Mounts on rear of Oak switches. Operates by switch shaft or separate concentric shaft.

**ELECTROSTATIC SHIELDS**—Used between sections. Sizes and shapes for all switches.

**BEARING STRAPS**—Added shaft support on long switches. Steel, brass, and phenolic.

**MOUNTING BRACES**—Prevents frame twist on long switches due to torsion.

**SPECIAL SHAFTS**—Hollow, dual-concentric, and triple-concentric for many switches.

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### SEND FOR THIS GUIDE CHART TO OAK SWITCHES

Bulletin unfolds to 17" x 22" wall chart (right) which matches 34 rotary switch sections (shown actual size) to corresponding frames. Also contains specifications and dimensions for rotary, pushbutton and lever switches.



CIRCLE 38 ON READER-SERVICE CARD



## NEWS

### Three Get Army Grant For Frequency Standard Work

Three University of Colorado faculty members have received a \$40,795 research grant from the Army Signal Corps to investigate the feasibility of developing a new frequency standard in regions from 100 to 400 kmc.

The faculty members are Dr. Frank S. Barnes, associate professor of electrical engineering; Dr. Donald G. Burkhard, professor of physics, and Dr. Masataha Mizushima, associate professor of physics.

The proposed instrument is expected to make use of the electrical resonance in molecules, and could be as much as 10 times more accurate than the present atomic frequency standards, it is said. The study will complement the work to be done on a \$57,000 research project Dr. Barnes received from the National Science Foundation recently to develop a millimeter wave-beam maser.

### 6 Basic Manufacturing Functions Turned Over to IBM Computer

Control of six basic manufacturing functions can now be accomplished by an electronic data processing system, according to International Business Machines Corp. Control is carried out by an IBM RAMAC 305 computer.

The functions said to be controlled are sales forecasting, materials planning, inventory management, plant scheduling, work dispatching and operations evaluation. Basic procedures in the automated process are input in punched card form, processing, and output of action documents and managerial reports.

RAMAC contains 50 discs rotating at 1200 rpm. Each disc has 100 tracks on each side, with 500 six-bit characters per track. Rental for the system is \$32,500 a month.

### Bookless Electronic Library Seen Within Five Years

Two electronic engineers have predicted an electronic library without books within five years. The heart of the library will be a computer. A. F. Glimm and R. D. Greenway of General Electric, Bethesda, Md., told the summer meeting of the AIEE.

In their paper, the two engineers said the state of the art in information systems techniques and equipment "is on the verge of a breakthrough that will eliminate many currently envisaged application problems. From the viewpoint of equipment and techniques, it will, within a few years,



Clare 2N597!

I've got specs and samples on my desk.

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> 45v,  $f_{\alpha b} \approx 8mc$ , 250 mw.

What do I use?

**LOW  $I_{CBO}$ , MEDIUM FREQUENCY, MEDIUM POWER**—these and other characteristics make 2N597-598-599 really valuable to the circuit designer. Prompt delivery in excellent quality, at reasonable prices. Clare talents and production capabilities combined... make these "hard-to-make" PNP germanium alloy devices easy to buy. Get started now... ask for specifications today. Contact your nearest C. P. Clare and Company Sales Office or C. P. CLARE TRANSISTOR CORPORATION, 260 GLEN HEAD ROAD, GLEN HEAD, L. I., NEW YORK.

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**2N597, 2N598, 2N599—Characteristics at 25°C**

	$f_{\alpha b}$		Max. Diss.	Min. $H_{FE}$ $I_C = -100mA$	Max. Rated $V_{CB}$	Max. $I_{CBO}$ $V_{CB} = -15Vdc$
	min.	typ.				
2N597	3mc	8mc	250mw	40	-45Vdc	-5 $\mu$ A
2N598	6.5mc	10mc	250mw	70	-35Vdc	-5 $\mu$ A
2N599	12mc	18mc	250mw	100	-30Vdc	-5 $\mu$ A

CIRCLE 39 ON READER-SERVICE CARD

be perfectly feasible to carry extremely large on-line digital computer storage."

They said automatic page readers, automatic information-indexing by the computer, bulk random-access memory, and high-speed electronic printing would all be available in less than five years.

### C-Band Klystron for Missiles Delivers 3-Megawatt Output

A C-band klystron said to deliver up to 3 megawatts peak output power has been developed by the Sperry Gyroscope Co. of Great Neck, N.Y. Intended for use in missile radars, it is the first microwave tube in its range capable of such a high power figure, according to the company.

The new klystron employs an electron gun that supplies a 100-amp current. The gun, considered standard in several of the company's high-power type klystrons, reportedly can supply beams of more than 200 megawatts power and 1,000 amp current.

Basic to the gun is a type of cathode described as an "extended interface coated cathode." This is a concave button of special nickel material, 1.5 in. in diameter, which supports a thin coating of standard cathode oxide coating material. The Sperry gun is also said to have an ultra high vacuum—less than one one-billionth of normal atmospheric pressure.



Sperry C-band klystron is said to give a 3-megawatt peak output. Pointed white cone (upper left) is a window made of a ceramic similar to sapphire which is transparent to microwave power. It passes output power to missile radar's antenna while sealing output pipe against tube's ultra-high vacuum.

**why** did **PACKARD BELL COMPUTER** select **ELCO VARICONS** for its new PB250 model?



**because**...the reliability

which Packard Bell required for its amazingly small, medium-scale, low cost model (capable of competing with large-scale, high cost models) was "... further increased by the use of Varicon Connectors." This is another example of another world famous manufacturer relying upon the reliability of the Varicon contact, with its unique forklike design and 4 coined mating surfaces. Packard Bell specified our Series 7001, 35 contact subminiature printed circuit Varicons. They are also available to you along with countless others for a limitless variety of applications. In each, you will find the same unchallenged reliability; plus the versatility challenged only by your own imagination!

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## PRINTED CIRCUIT CONNECTOR

### FEATURES:-

- 1 bifurcated undulating accordion spring assures multi-point contact
- 2 shortest front-to-back dimension available—lightest in weight—no insulating sleeves needed
- 3 closed entry face protects springs and self-aligns warped boards
- 4 HYFEN pins (straight shank-solid barrel) have multi-point contact surfaces and independent detent locking action
- 5 gold plated, crimp-type, snap-in, removable HYFEN tips with insulation grips
- 6 closed entry on wire lead side prevents oversize probe damage
- 7 1 or 2 wire leads for each board position on each side  
low board insertion and withdrawal forces  
designed for dry circuit as well as power applications  
commoning clips and jumpers available for joining circuits  
polarizing key available for any contact position for pre-notched boards

\*T.M. \*

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CIRCLE 41 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

# EDITORIAL

## A Fair Week's Work for a Fair Day's Pay

Are we asking our National Bureau of Standards to do a "fair week's work for a fair day's pay?" In recent years we've placed greater and greater responsibilities on NBS with only trifling increases in appropriations. We seem unwilling to provide enough money for NBS to develop the super-accurate standards that our country urgently needs.

Today, our inability to measure with adequate accuracy limits us severely on many technological fronts. In rocketry, for example, we want to measure thrust to within 0.01 per cent. We can't.

In vhf, uhf, and microwave measurements, NBS can provide only about 20 per cent of the specific calibration services required.

It was reported recently that one company could have saved several months of schedule time and several hundred thousand dollars in developing a high-power klystron if adequate NBS power-calibration services had been available.

Another company could have saved almost a million dollars. If adequate attenuation calibration services had been available in the Ku-band, the company could have obviated a million-dollar trial-and-error approach in designing an antenna radome.

If NBS can improve the accuracy of force measurement by a factor of 10, a rocket manufacturer can reduce the number of rocket tests and save the taxpayer a fat \$93 million—more than five times the direct congressional appropriation (\$17.5 million) for NBS in FY'60.

In 1950, there were no Sputniks and no apparent challenges to our scientific and technological supremacy. By 1960, our supremacy was very much in dispute, and NBS had just reached the scientific manpower level it enjoyed in 1950.

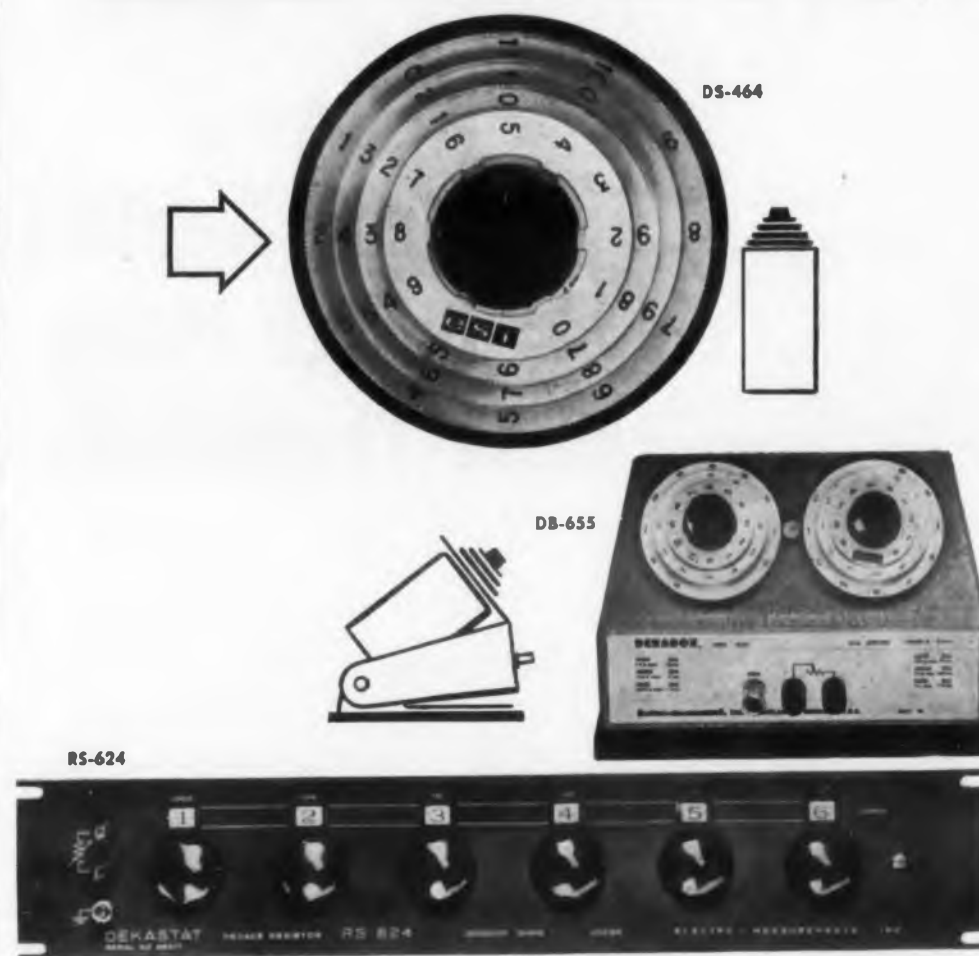
In 1950, NBS had a direct congressional appropriation of \$7.85 million for research and technical services. In 1960, despite the much-cheapened dollar, despite the vital role NBS must play in our race for technological supremacy, despite the vastly broadened measurement front which NBS must cover, the appropriation was only \$17.5 million.

We demand a lot from NBS. We need better accuracies, increased ranges of measurement, and new categories of measurement. Are we willing to pay for them?

*George H. Rostky*

**esi**

# DECADE RESISTORS



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# Wideband Video Amplifier Design Using Mesa Transistors



*Design details for a 150-mc video amplifier strip having an overall gain of 50.5 db. Simple circuitry, requiring RL shunt feedback for each stage, is in part due to the low collector capacitance associated with mesa transistors.*

**William A. Rheinfelder**

Motorola Semiconductor Products, Inc.  
Phoenix, Ariz.

**W**IDE BAND video amplifier design using vacuum tubes generally includes distributed lines with their inherent complexities. To accomplish the same objectives, mesa transistors using simple RL shunt feedback can be employed; the high frequency peaking adjustment,  $L$ , is not critical and the amplifier produced is simple and stable.

## Choice of Operating Conditions

To achieve widest bandwidth, it is generally necessary to optimize the operating conditions for the largest  $f_t$ , the frequency at which the ratio of collector current to base current with output shorted becomes unity. As can be seen from the data for a type 2N700, Fig. 1,  $f_t$  is within 10 per cent of maximum from 5 ma to about 14 ma and for collector voltages above 4 v. In Fig. 2, the gain-bandwidth product is plotted and is seen to follow  $f_t$  directly. Within the limits given, a gain-bandwidth product of about 800 mc can be expected. The actual choice of operating conditions depends on a number of additional factors such as dissipation, signal handling capability and noise figure.

From Fig. 3a, it is seen that the noise figure at 70 mc (which is in the center of the proposed band) increases above a collector voltage of 10 v. From Fig. 3b, it can be seen that the best noise figure occurs at about 2 ma emitter current. For good signal handling (high undistorted output power), high collector voltage and current are required. The maximum is given by the dissipation rating of the 2N700. The input stage on the other hand, should be designed for low noise.

Summarizing, the following operating conditions can be obtained:

Input Stage	$I = 5 \text{ ma}$ $V_{ce} = 5 \text{ to } 10 \text{ v}_e$
Intermediate Stages	$I = 8 \text{ ma}$ $V_{ce} = 5 \text{ to } 10 \text{ v}_e$
Output Stage	$I = 8 \text{ ma}$ $V_{ce} = 10 \text{ to } 15 \text{ v}_e$

The higher collector voltages are attractive in that they decrease  $C_{ob}$ , as shown in Fig. 4.

The change in operating conditions is only slight for the different stages; for simplicity, identical circuitry may be used except for the output stage. In this case the noise is about 1 db worse than optimum.

## Circuit Design of Feedback Stage

From Fig. 2, a gain-bandwidth product above 800 mc may be reached, corresponding to a gain of about 5.3 per stage (or 14.5 db) for a 150-mc bandwidth. The mismatching loss in a video amplifier is usually high because no transformer

matching is possible. The ratio of output to input resistance ranges from 10 to 5 for the 2N700. Therefore, we can expect a gain of only from 8 to 10 db per stage in practice. The total number of stages for the 50-db gain is then five, plus one emitter follower. (This has been confirmed by the experimental chassis discussed later.)

The common-emitter configuration was chosen for two reasons. One, as has been pointed out above, in a video amplifier matching using transformers is not possible. Therefore, the closer to unity the ratio of output impedance to input impedance, the greater the iterative power gain. This eliminates the common-base circuit. The common collector also provides, at low power gain, the impedances involved. The second reason for not using a common-base connection is that it does not improve rf stability in mesa transistors, since grounding the base does not lower the capacitance between input and output.

The base of a mesa device is just a stripe on the collector and does not separate emitter and collector as in an alloy transistor.

The collector capacitance of the mesa transistor is low enough so that no neutralization is required. Since satisfactory neutralization would be very difficult to achieve in a wide-band amplifier, it is essential that a transistor with a low  $C_o$  be used.

The simplified circuit of one stage is shown in

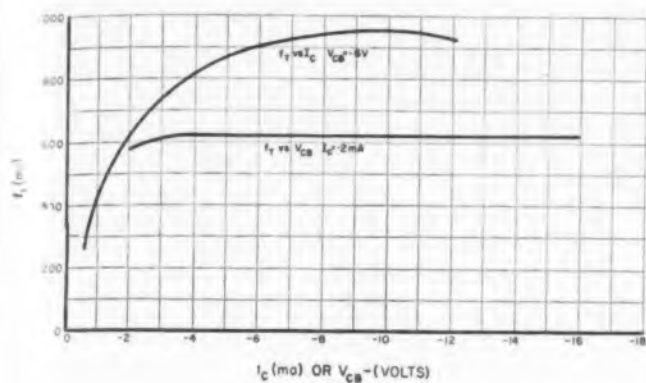


Fig. 1. Above 4 v collector voltage and in the region of 5 to 14 ma collector current,  $f_t$  is flat within 10 per cent ( $f_t$  is the frequency at which the ratio of collector current to base current is unity with output shorted). Curve represents data for a type 2N700 mesa transistor at 25 C.

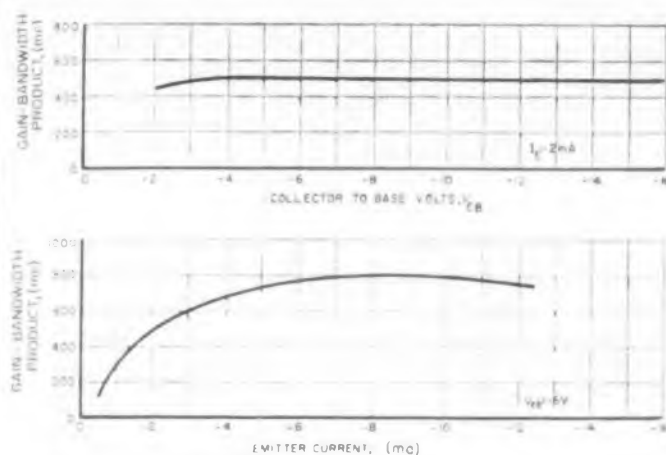


Fig. 2. The 2N700 gain-bandwidth product is reasonably flat between 5 to 14 ma emitter current and above 5 v collector voltage.

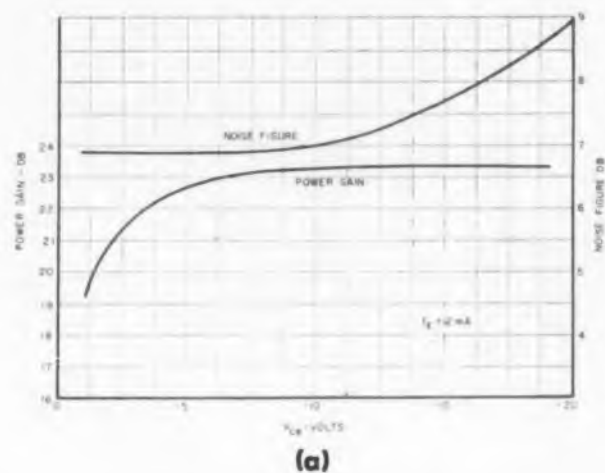


Fig. 3. At 70 mc, center of the proposed video amplifier band, the noise figure increases above a collector voltage of 10 v (a) with minimum noise figure at about 2 ma emitter current (b).

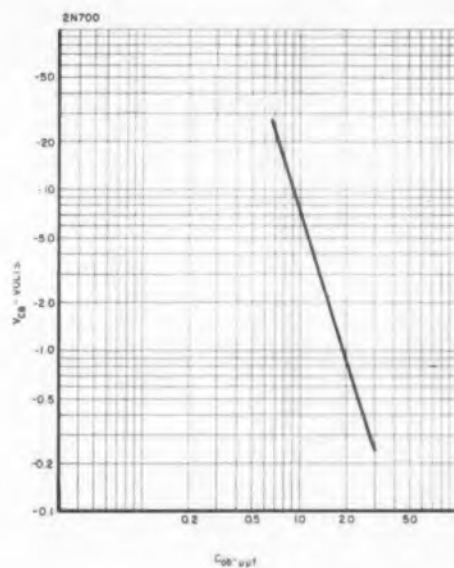
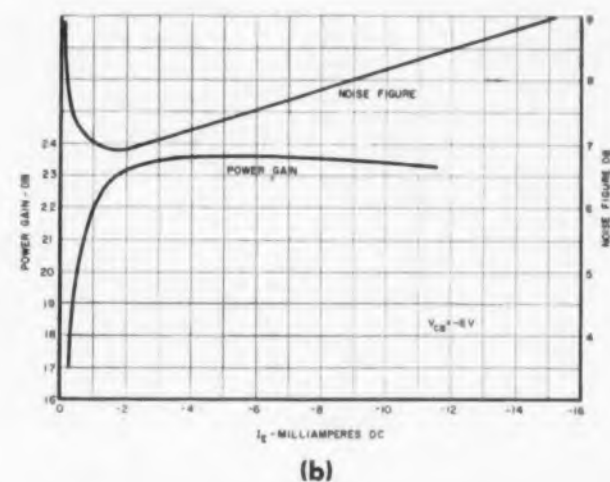


Fig. 4. Collector capacitance decreases as collector voltage is increased for a 2N700 transistor.

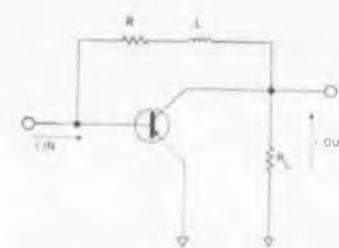


Fig. 5. Simplified schematic of a single stage amplifier using an RL feedback network.

Fig. 5. As can be seen, simple shunt feedback is provided from collector to base to lower both the input and output impedances of the stage. A strict analysis of this stage using the equivalent circuit of the transistor is cumbersome and leads to inaccurate results since the greater part of the load consists of the feedback network in parallel with the frequency-variable input impedance of the following feedback stage. For a more detailed analysis the literature listed should be consulted.<sup>1, 2, 3</sup>

The approximate estimate presented is satisfactory as a start; optimum values of the feedback resistor and coil must be determined by experiment. It is first necessary to calculate the input impedance of the feedback stage shown in Fig. 5. Assuming there is no coil, it is easily shown that the effective input impedance is simply the input impedance of the transistor in parallel with a resistance equal to the feedback resistor divided by  $(1 - A)$ , where  $A$  is the voltage gain, collector to base. This last resistance  $R_f/(1 - A)$  is the smaller resistance and can therefore be considered equal to the approximate input resistance of the stage.

The load seen by the collector of the preceding stage consists chiefly of this resistance in parallel with the feedback resistance of the stage. The total load resistance is then smaller than  $R_f/(2 - A)$ . With this value, the gain  $A$  can be found to be  $A = -g_m \cdot R_f/(2 - A)$ .

#### Calculating Feedback Resistor $R_f$

As previously shown from gain-bandwidth considerations, the gain per stage will be approximately 3. Substituting this and  $g_m = 60 \times 10^{-3}$  mhos into the gain formula,  $R_f$  is found to be 250 ohms.

Feedback resistor  $R_f$  can also be found without using the gain-bandwidth product and using the input capacitance of the transistor instead, as follows:

$X_c$  must be determined at 150 mc. Taking 12  $\mu\text{f}$  for the transistor, and 8  $\mu\text{f}$  for socket, wiring and contribution by  $C_x$ ,  $X_c$  is found to be 50 ohms at 150 mc. At this cut-off frequency,  $X_c$  must be equal to the input resistance which was found above to be  $R_f/(2 - A)$ .

Therefore  $R_f/(2 - A) = X_c$ . With  $X_c = 50$  ohms and  $g_m = 60 \times 10^{-3}$  mhos,  $A$  is  $-3$ . Substituting this into  $R_f/(2 - A) = X_c$ ,  $R_f$  is found to be 250 ohms as above. A practical range would be 220 to 270 ohms.

The feedback coil inserted in series with this resistor decreases the feedback at the high end only.  $X_L$  should therefore be about 220 to 270 ohms at 100 mc.  $L$  is then 0.33 to 0.47  $\mu\text{h}$ . These values give good starting points, but a variation of at least 2:1 may be expected in a practical circuit.

To obtain the proper dc operating conditions, a separate emitter supply is used. As pointed out above, the emitter current chosen is 8 ma, therefore, the emitter resistance for a 4.5-v supply voltage is 560 ohms. This value provides all the stability required since the dc resistance in the base circuit is very low.

#### Output Stage

A similar feedback stage is not capable of delivering a level such as 0.3 v into a 50-ohm load, without overload which appears as compression

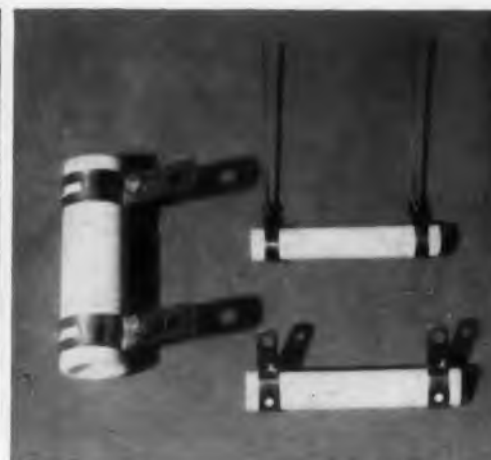




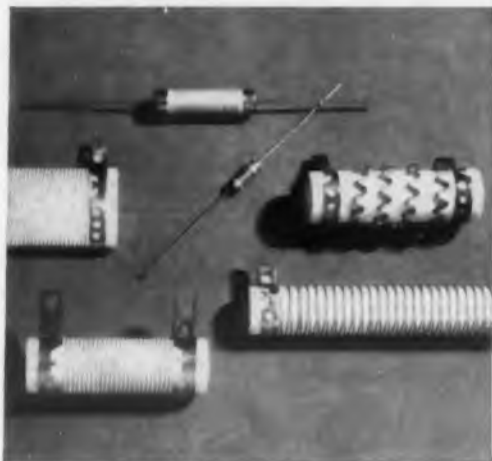
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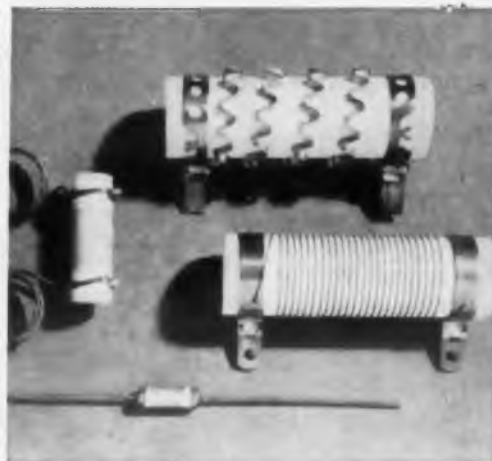
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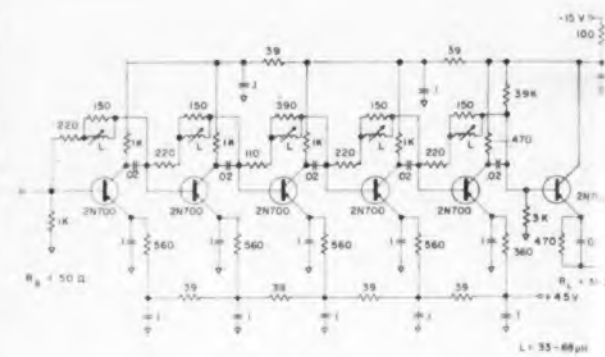
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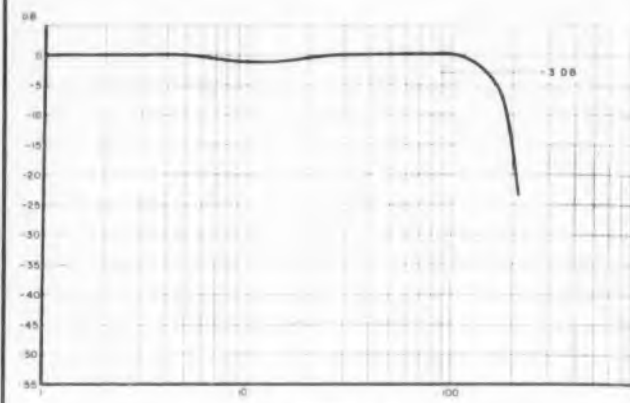
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(a)



(b)

Fig. 6. Schematic diagram (a) of a five-stage amplifier having a 150-mc bandwidth and an overall gain of 50.5 db; an emitter follower output delivers up to 0.3 v into a 50-ohm load. The overall frequency response is shown in (b).

of power gain and change of frequency response. It is thus necessary to design a special output stage using an emitter-follower. Because of the low impedance involved, a direct-coupled arrangement is used; the emitter current passes through the 50-ohm load directly. To increase the stability, a bypassed series resistor is used in the emitter circuit. Because of the method of load connection, a separate emitter supply voltage cannot be used and bias is applied to the base by a resistive divider. The total input impedance of the emitter-follower is of the order of 1 K and is sufficiently high to avoid loading the previous stage unduly.

### Performance and Practical Considerations

A schematic diagram of the complete amplifier is shown in Fig. 6a. Individual stages are not identical; this is not due to variation of transistor parameters but due to the flatter over-all response possible with a cascade of slightly different stages. If identical stages are cascaded, each with  $R_f = 200$  ohms and  $L_f = 0.33 \mu\text{h}$ , it is found that the frequency response is flat on the high end but a severe dip (of 6 db or more) is encountered in the region from 30 to 80 mc. This dip is not sharp but

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wide-band and is not caused by faulty bypass capacitors or the like. It is probably caused by beta roll-off of the transistors which, at the high end, is corrected by the coil.

By lowering the  $Q$  of the chokes with shunting resistors, adjusting the frequency by choice of the choke inductance, and applying some variation in the amount of feedback applied, it is possible to improve the frequency response considerably as shown in Fig. 6b. In the final circuit a gain of 50.5 db was obtained at 1 mc. The maximum undistorted output signal was 0.3 v although up to 1 v is available for pulses. The noise level with input terminated in 50 ohms is 4.8 mv at the output. For a bandwidth of 150 mc this corresponds to an equivalent input noise resistance of 95 ohms, neglecting the difference between noise bandwidth and the 3-db bandwidth.

Since the input impedance is approximately 50 ohms when terminated with 50 ohms, the equivalent thermal resistance is approximately 25 ohms. The noise figure is therefore  $\sqrt{95}/\sqrt{25} = 1.95$  or 5.8 db. No special care has been taken so far to optimize circuit design in the first stage for least noise. Although the low end is down 3 db at 350 kc, shown in Fig. 6b, no special emphasis has been placed on extending the low end since it is simply a matter of increasing the value of the coupling and bypass capacitors.

#### Other Possible Circuits

Shunt feedback amplifiers as used here and elsewhere<sup>1,2,3</sup> are not the only way to design wideband amplifiers. Emitter degeneration and mismatching<sup>4,5</sup> have been used. A design could also be based on two-stage feedback amplifiers, which use series compensation in the interstage network and feedback from the second collector into the first emitter or from the second emitter into the first base. Both circuits have been tried successfully<sup>6</sup> and are useful for amplifiers of smaller bandwidth and higher gain. ■ ■

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*Just how good is Russian test equipment? How do Russian designs compare with ours? Are Russian instruments more sensitive—their ranges wider?*

*If the quality of electronic test equipment can be a clue to the quality of microwave, ultrasonic, telemetry, switching, and other types of equipment, then surely there is much to be learned from a good look at Russian test equipment.*

*Bruno Weinschel, president of Weinschel Engineering and chairman of the Washington Chapter of the IRE Professional Group on Instrumentation, has prepared photographs and technical descriptions of instruments shown at the Russian Exhibition in New York last year. His material was published in the December 1959 IRE Transactions on Instrumentation.*

*To give readers a more direct comparison with equivalent American Equipment, ELECTRONIC DESIGN is pleased to present 21 photos and descriptions of these instruments together with 37 American instruments which appear similar. Though the Russian specifications were, in places, very meager, American manufacturers were extremely cooperative in making some very difficult comparisons. In many cases, full comparisons were impossible because the Russian specifications failed to cover essential instrument characteristics.*

*In addition to these equipment comparisons, this report includes comments on Russian equipment, design, and manufacturing approaches by Donald Sinclair and by David Packard based on their recent trips to the Soviet Union. There are additional comments by William Bourke based on his appraisal of the Russian instruments when he saw them in New York.*

IN JULY of 1959, the Russians showed many pieces of electronic test equipment at their Exhibition of Science, Technology, and Culture at New York City's Coliseum. Since most engineers want to know how Russian test equipment compares with ours, members of the Washington chapter of the IRE Professional Group on Instrumentation examined some 30 instruments on display.

Through the courtesy of the Soviet Press Attaché, they were allowed to photograph the instruments. The Russian exhibitors provided performance specifications in English. PGI members discussed design details of some of the most interesting instruments with one of the Russian engineers.

J. F. Raible of Forest Hills, N.Y., took pictures of the instruments and E. E. Anderson of the Naval Ordnance Laboratories translated the front-panel lettering.

#### **Translation of Panel Markings May Be Misleading**

The reader should be warned that translation of the panel markings, without access to instruction books and details of instrument operation, is risky and somewhat uncertain. The problem is lack of context to guide the choice of possible English equivalents. For example, a commonly

## Russian Test Equipment and Ours

**Bruno O. Weinschel**

Chairman, Washington Chapter  
IRE Professional Group on Instrumentation

occurring Russian marking could be translated as "adjustment," or "monitor."

Abbreviations can be even more troublesome. In many cases, knowledge of the instrument's function and probable design sufficed to resolve this type of ambiguity, but there are surely cases where English words with incorrect connotation have been selected.

The PGI members had no opportunity to observe any of the Russian instruments in operation, so they could not comment on possible differences between actual performance and specifications.

#### **Compact Attenuation Calibration Has 110-db Dynamic Range**

One of the most interesting units shown was that in Fig. 17. Used for calibrating signal gener-

ators, it has a dual frequency range of 100 kc to 25 mc and 15 to 3000 mc. It uses the parallel if substitution principle discussed.<sup>1,2,3</sup>

It operates at 5 mc and has a 100-kc bandwidth. One may use either its 2-in. oscilloscope or its 5-in. zero-center meter for null balancing the 5-mc mixer output against the 5-mc standard if source.

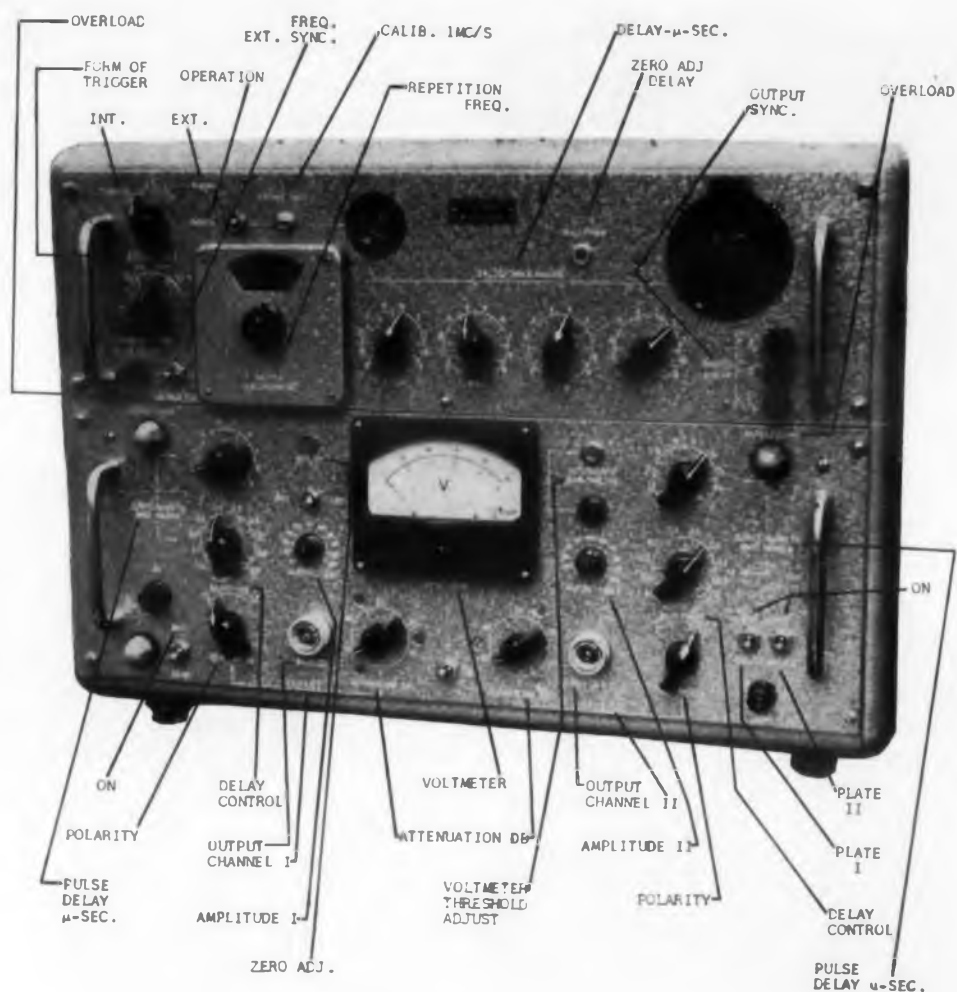
While the principle of this instrument is known in the United States, and at least two units have been built for laboratory measurement of signal generators, the Russian instrument covers a wider dynamic range than the American instrument. Furthermore, it has been condensed into two relatively small, portable cabinets.

According to a Russian engineer at the New York show, the instrument is used in all Russian factories where output attenuators of signal generators must be calibrated.

From an engineering point of view, there is considerable difficulty in packaging equipment with a dynamic range of 110 db into such a small space. The practical difficulties in overcoming undesired coupling in such a small package are considerable.

#### **Instrument Features Low Vswr Over Wide Frequency Range**

Another interesting feature of this unit is its external mixer head. This mixer has a vswr of less than 1.2 over a range from 15 to 3,000 mc. It can



## Pulse Generators

**Fig. 1.** Pulse Generator GI-4M has delay time between channel pulses between 0 and 10 msec, with accuracy within  $\pm (0.05 \mu\text{sec} + 0.05 \text{ per cent})$ . Pulse rise time does not exceed 50 nsec. Repetition frequency with internal triggering varies from 2 cps to 10 kc, accuracy being within 10 per cent.



**Fig. 1a.** Allen B. Du Mont. Pulse Generator 404, with repetition rates from 10 cps to 100 kc, has wider frequency range than the Russian instrument, and its 20-nsec maximum rise time is better than the 50 nsec for the Russian unit. The Russian unit has two channels, the Du Mont only one.



**Fig. 1b.** General Radio. Pulse, Sweep, and Time Delay Generator 1391-B can provide pulse lengths as long as 1 sec and repetition rates to 250 kc. Its 50-nsec rise time is equal to that of the Russian instrument.

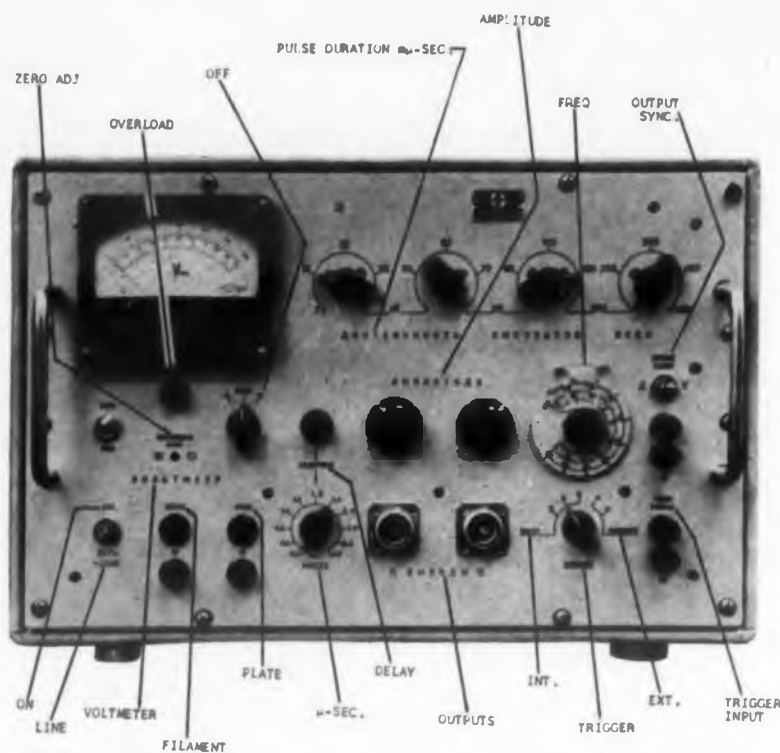


**Fig. 1c.** Hewlett-Packard. Digital Delay Generator 218A with Dual Pulse Unit 219B has specifications which are almost identical to the Russian specifications. The 219B Dual Pulse Unit has a slightly longer rise time (60 nsec) but a 219C has a slightly faster rise time (30 nsec).



## RUSSIAN TEST EQUIPMENT

### Pulse Generators (continued)



**Fig. 2.** Short-Pulse Generator GJ1-5 measures transient characteristics; tests and aligns pulse circuits, broadband amplifiers, analyzers, discriminators; and tests semiconductor coincidence circuits. Can also be used as modulator of shf oscillators. Pulse duration: 7 to 500 nsec. Rise time 6 nsec. Fall time: 10 nsec. Repetition frequency: 10 cps to 10 kc.



**Fig. 2a.** Measurements. Standard Pulse Generator 179 has a higher upper frequency limit (60 cps to 100 kc). Its rise and fall times (100 and 150 nsec) are substantially longer than the 6 and 10 nsec times for the Russian unit. Pulse width of the 179 is continuously variable from 0.5 to 60  $\mu$ sec while Russian unit has fixed pulse width of 0.5  $\mu$ sec.

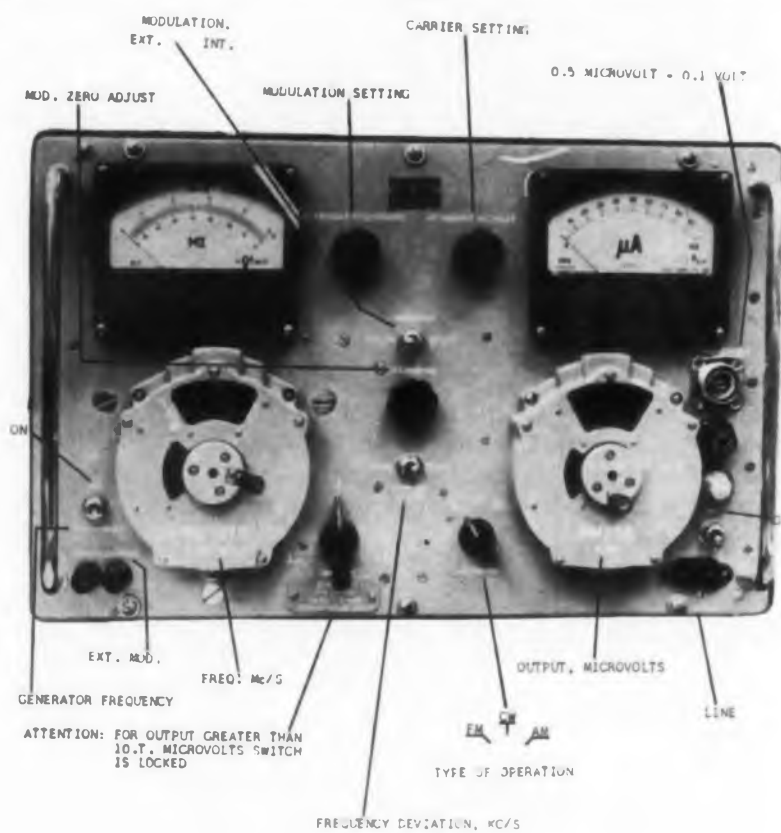


**Fig. 2b.** Rutherford Electronics. Pulse Generator B7 has repetition rates of 20 cps to 2 mc with variable pulse delay to 10 msec. Pulse width is variable from 50 nsec to 10 msec. Rise and fall times are 15 nsec each.



**Fig. 2c.** Electro-Pulse. Megacycle Pulse Generator 3450C provides repetition rates from 2 cps to 2 mc with variable pulse delay to 10 msec. Pulse width is variable from 50 nsec to 10 msec. Rise time is 15 nsec.

## Sine-Wave Generators



**Fig. 3.** Standard-Signal Generator GSS-17 tests and aligns fm and am receivers. Frequency range: 16 to 128 mc. Generator provides: a) continuous oscillation; b) internal 1-kc frequency- or amplitude-modulation with modulation factors from 10 to 80 per cent and frequency deviation from 1 to 75 kc; c) external frequency modulation by sinusoidal voltages from 50 cps to 15 kc, providing frequency deviation from 1 to 75 kc; d) external amplitude modulation by sinusoids from 100 cps to 10 kc, providing modulation percentage from 10 to 80 per cent. Nonlinear distortion with internal fm does not exceed 3 per cent. Nonlinear distortion with internal am does not exceed 3 per cent. Nonlinear distortion with internal am does not exceed 5 per cent.



**Fig. 3a.** Measurements. Standard Signal Generator 80, with a range of 2 to 400 mc covers the ranges of the Russian GSS-17 and GSS-30 (Fig. 4). Internal amplitude modulation is at 400 or 1000 cps while the Russian GSS-17 provides only 1000 cps. Modulation is variable from 0 to 30 per cent compared with 10 to 80 per cent for the GSS-17 and 10 to 60 per cent for the GSS-30.

operate with inputs as high as 0.3 without deviating from linearity. To the writer's knowledge, no similar performance specifications for a mixer have ever been published in U. S. catalogs or reports. Most good American mixer heads in coaxial lines below 4 kmc have a vswr of 2 over a single octave.

#### High- and Low-Power Outputs Common in Russian Generators

A number of the Russian instruments on display had high as well as low power outputs. The existence of two independent power outputs permits the use of homodyne systems. It also allows the use of the high-level output for automatic local-oscillator correction with very narrow-band systems for transmission measurements. The low-output level can be used for calibration. The instruments in Figs. 13 and 14 have high and low output levels. The one in Fig. 13 has an unusually high output exceeding 1 w below 1 kmc and 0.5 w between 1 and 2 kmc.

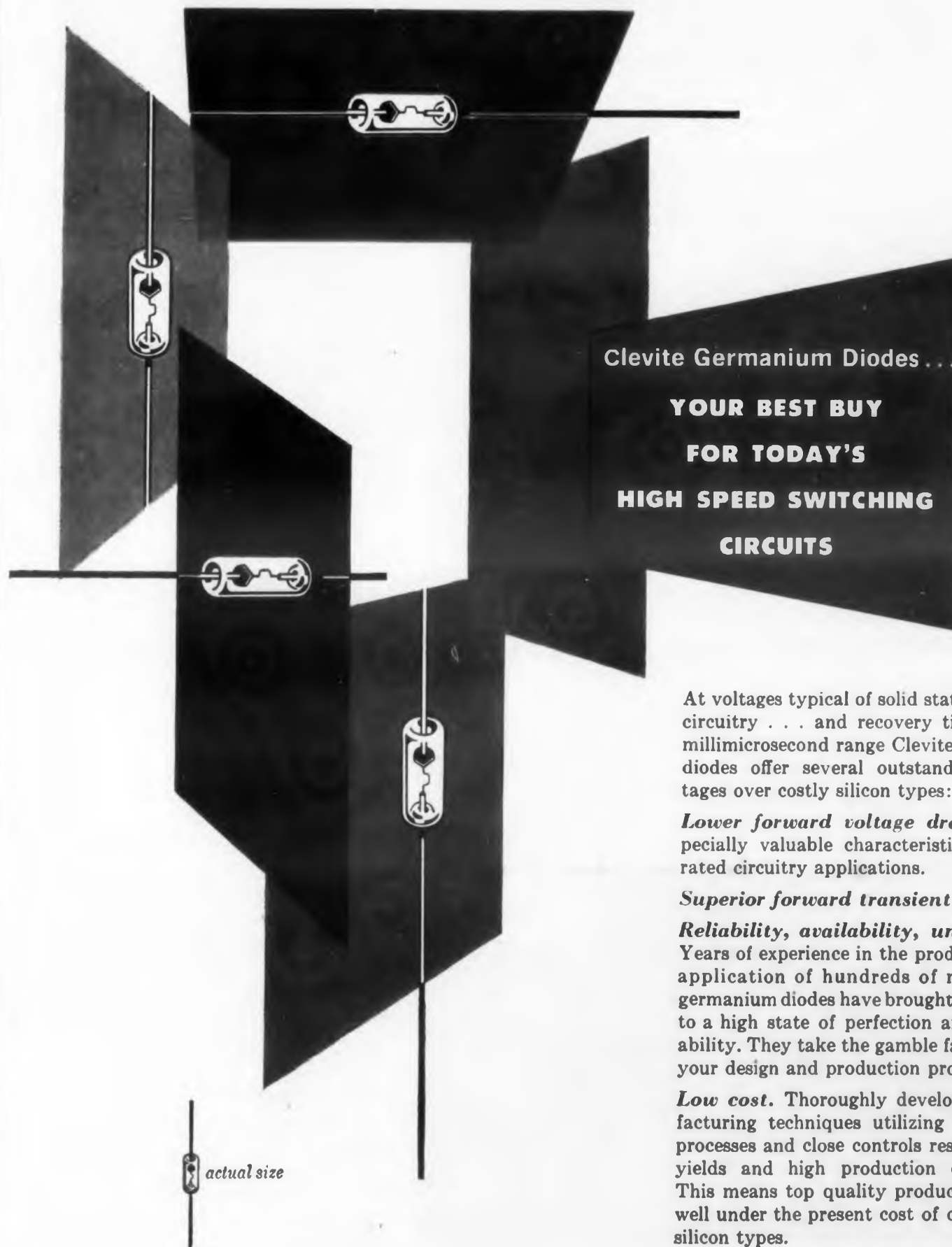
#### Strong Central Planning Minimizes Choice of Equipment

It appears that because of strong central planning, only a small choice of standardized electronic test equipment is available to Russian engineers. Since there is no commercial competition, no effort is apparent in streamlining instruments or miniaturizing equipment. The equipment appears bulky, but functional.

It should be noted that some measurements, such as the calibration of the output power of



**Fig. 3b.** Boonton Radio. FM-AM Signal Generator 202-E provides both am and fm coverage for a wider range of frequencies than does the GSS-17. It covers 54 to 216 mc while the latter covers 16 to 128 mc. The 202-E gives from 0 to 50 per cent modulation and provides eight internal-modulation frequencies from 50 cps to 60 kc. Am distortion of less than 5 per cent is the same for both instruments but the Boonton gives less than 2 per cent fm distortion (compared with 3 per cent) over a very wide fm range of 0 to 240 kc (compared with 0 to 75 kc). External am fidelity is 30 cps to 200 kc for the 202-E and 100 cps to 10 kc for the GSS-17 while external fm fidelity is 30 cps to 200 kc for the Boonton and 70 cps to 15 kc for the Russian unit.



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## RUSSIAN TEST EQUIPMENT

### Sine-Wave Generators (continued)

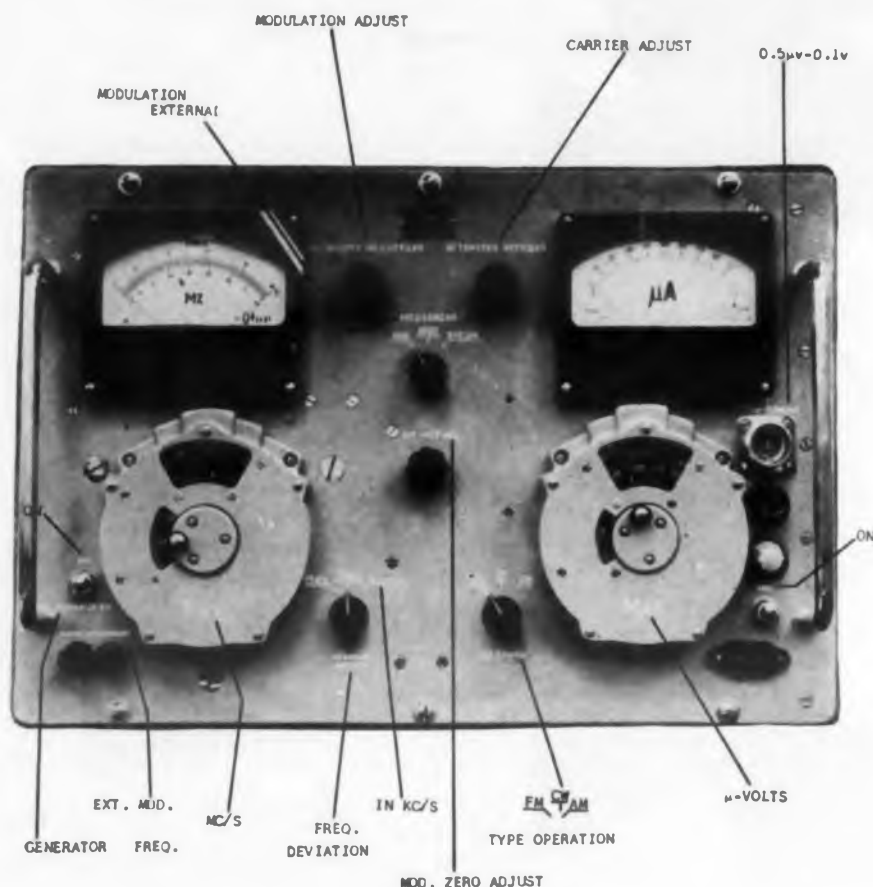


Fig. 4. Standard-Signal Generator GSS-30 tests and aligns uhf am and fm receivers. Frequency range: 125 to 250 mc. Generator provides a) continuous oscillations; b) internal frequency- or amplitude-modulation by a 400- or 1000-cps sinusoid with modulation factors from 10 to 60 per cent and frequency deviation from to 150 kc; c) external frequency- or amplitude-modulation by a sinusoid from 100 cps to 10 kc, with modulation percentage from 10 to 60 per cent, and deviation from 1 to 150 kc. Modulation distortion with internal amplitude modulation does not exceed 5 per cent.

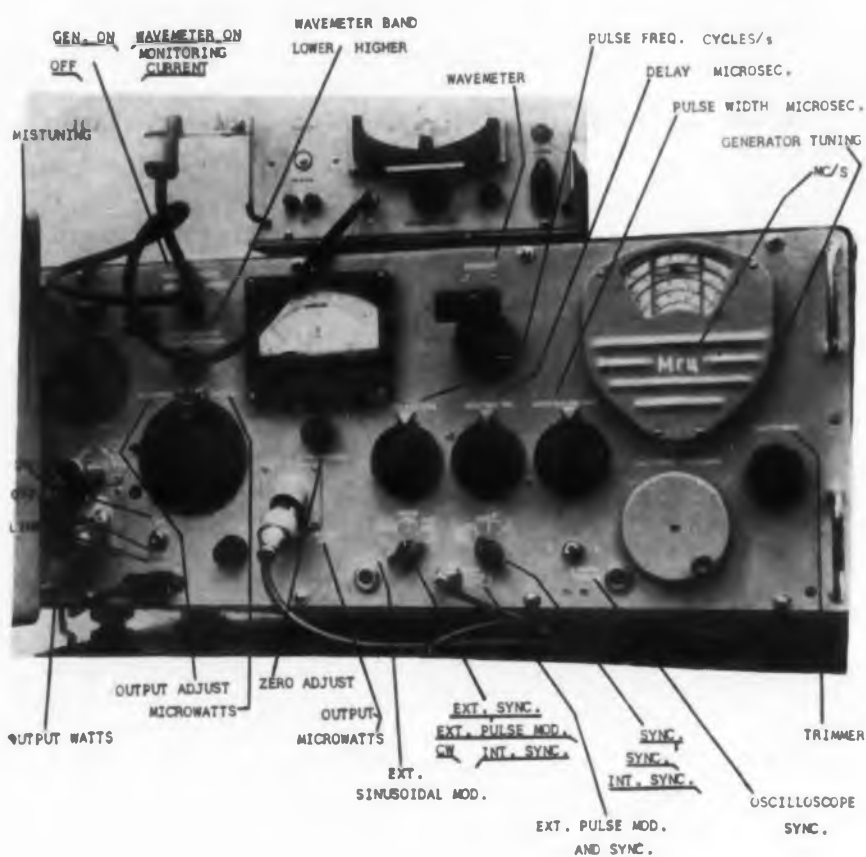


Fig. 5. Standard Signal Generator GSS-15 aligns receivers and feeds instrument lines, antennas, and other radio devices. Available in model GSS-15A from 150 to 1000 mc and model GSS-15B from 1 to 2 kmc. Power output: a) from microwatt output connector: 100 to  $10^{-8}$   $\mu$ w; b) from high-power output connector: at least 1 w (GSS-15A), at least 0.5 w (GSS-15B).

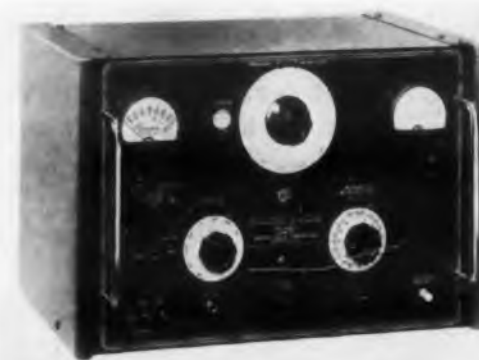


Fig. 4a. Boonton Radio. FM-AM Signal Generator 202-G, designed for the telemetry band is very much similar to the GSS-30. It covers 195 to 270 mc (compared with 125 to 250 mc). Am modulation is from 0 to 100 per cent (compared with 10 to 60 per cent). Fm modulation from 0 to 240 kc provides greater fidelity than the 1 kc to 150 kc in the Russian unit. (The instruments in Fig. 3 can also be compared with the GSS-30.)



Fig. 5a. Hewlett-Packard. UHF Signal Generator 612A, covering 450 to 1230 mc, overlaps the frequency range of the GSS-15A and the GSS-15B. The H-P 614A covers 800 to 2100 mc and the H-P 608D covers 10 to 480 mc. Maximum power output of the GSS-15A (1 w) and of the GSS-15B (0.5 w) exceed that of the H-P (5 mw).

Signal generators (which we consider rather complex even in a specialized laboratory), are handled on a routine basis in Russian electronics factories using signal generators. ■ ■

#### References

1. G. F. Gainsborough. A Method of Calibrating Standard Signal Generators and Radio Frequency Attenuators. *J. IEE*. Vol. 94. May, 1947. pp 203-210.
2. A. L. Hedrich, B. O. Weinschel, G. U. Sorger, and S. J. Raff. Calibration of Signal Generator Output Voltage in the Range of 100 to 1000 Megacycles. *IRE Trans. on Instrumentation*. Vol. 1-7. Dec, 1958. pp 275-279.
3. B. O. Weinschel, G. U. Sorger, and A. L. Hedrich. Relative Voltmeter for Vhf/Uhf Signal Generator Attenuator Calibration. *IRE Trans on Instrumentation*. Vol. 1-8. March, 1959. pp 21-31.

## U.S. Manufacturers Say:

INSTRUMENT comparisons based solely on the Russian equipment shown in New York suffer from basic drawbacks: these comparisons don't show how old a particular piece of equipment is nor how widespread its use. It is not particularly revealing to compare an American instrument, vintage 1947, with a just-out-of development Russian instrument.

### Russian Test Equipment Five-Ten Years Behind Ours

In many cases, the Russians appear to be far behind us. William Bourke, president of Narda Microwave Corp., told *ELECTRONIC DESIGN*, "Our appraisal of the Russian units when we saw them at the Coliseum was that they have the general appearance of products that might have been manufactured here five or ten years ago."

Mr. Bourke pointed out that in microwave test equipment, there haven't been significant technical advances in the United States over the past 10 years but the products presently being manufactured here are greatly refined and offer better accuracy, more attractive appearance, and a long list of design improvements over earlier versions.

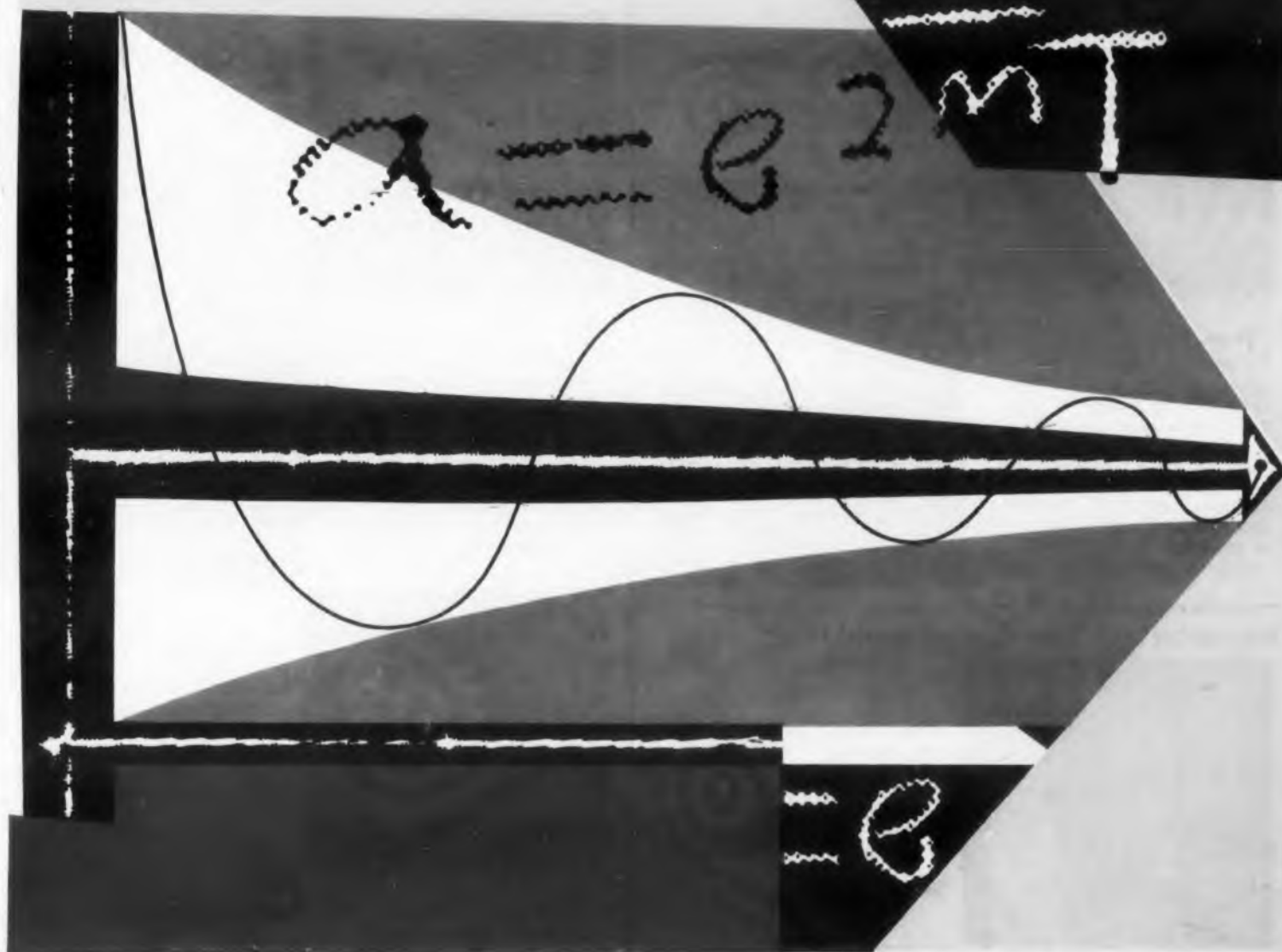
### Russian Test Equipment Looked Ugly—But Useful

The accuracy of microwave test equipment depends primarily on good mechanical design and high accuracy in machining and assembling operations. "Their design," continued Mr. Bourke, "appeared adequate. So I am surprised that their specifications are so much poorer than ours. I assume they have available, if they wish to use it, a machining capability comparable to our own."

Concluding, Mr. Bourke commented, "The Russian equipment looked ugly—but useful."

(text continued on page 59)

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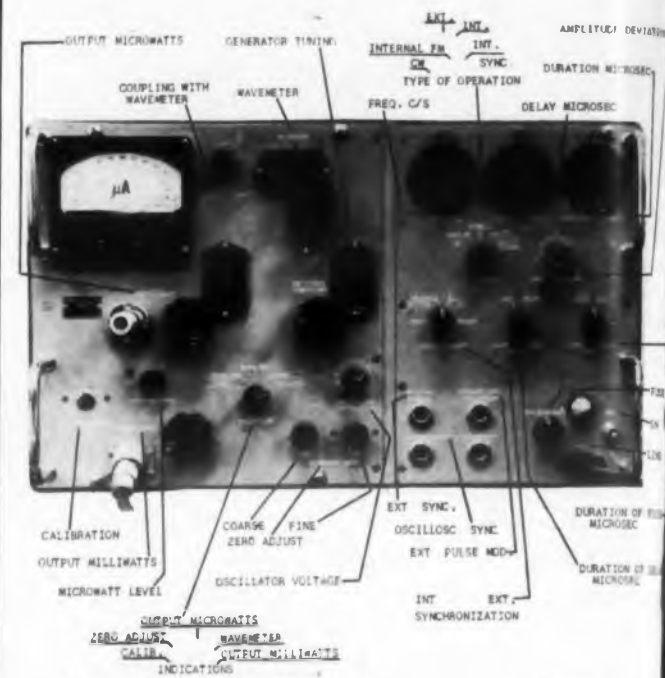
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## RUSSIAN TEST EQUIPMENT

### Sine-Wave Generators (continued)



**Fig. 6.** Standard-Signal Generator GSS-28M adjusts receivers and feeds measuring lines, antennas and other radio devices. Frequency range: 3750 to 4750 mc. Basic frequency error 2 per cent.



**Fig. 6a.** Hewlett-Packard UHF Signal Generator 616B covers 1.8 to 4.2 kmc, a slightly wider range than the 3.75 to 5.75 kmc of the Russian unit. The 1 per cent frequency accuracy of the H-P instrument is twice as good as that of the Russian unit.

## Modulation Meters

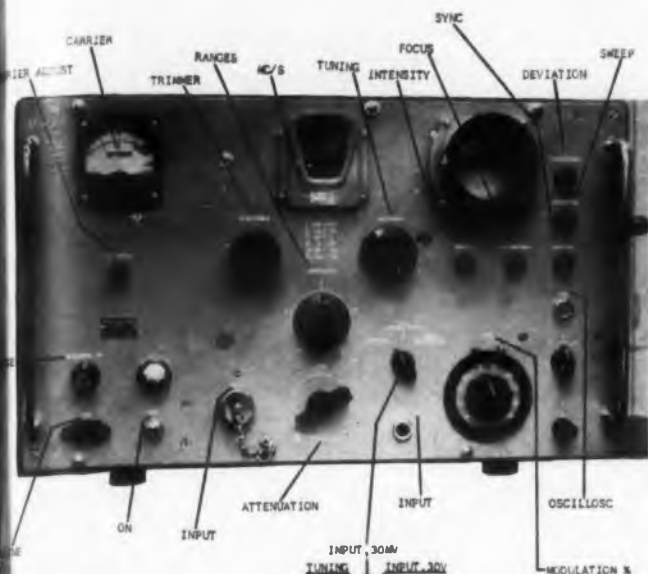


Fig. 7. Modulation Meter IM-19 measures amplitude-modulation percentage and frequency deviation. Ranges: 80 kc to 180 mc for selective input, 150 kc to 30 mc for untuned input. Frequency-deviation range: 400 kc to 180 mc. In amplitude modulation, the modulation-factor range for "up" and "down" separately is 10 to 100 per cent. Deviation-frequency range: 1 kc to 50 kc.



Fig. 7a. General Radio. Amplitude-Modulation Monitor 1931-B measures am per cent modulation from 0 to 110 per cent on positive peaks, to 100 per cent on negative peaks. Works with carriers from 0.5 to 60 mc. Does not have as wide a frequency range as the Russian equipment but per cent modulation range is wider. G-R instrument does not measure frequency deviation. Intermediate frequency of the systems being tested should not exceed 100 mc with maximum bandwidth of 15 mc. Noise source can be mounted on front panel. Though it detracts from appearance, it is convenient when equipment under test is nearby. For other applications, it appears that noise source and cable can be unhooked from front panel.

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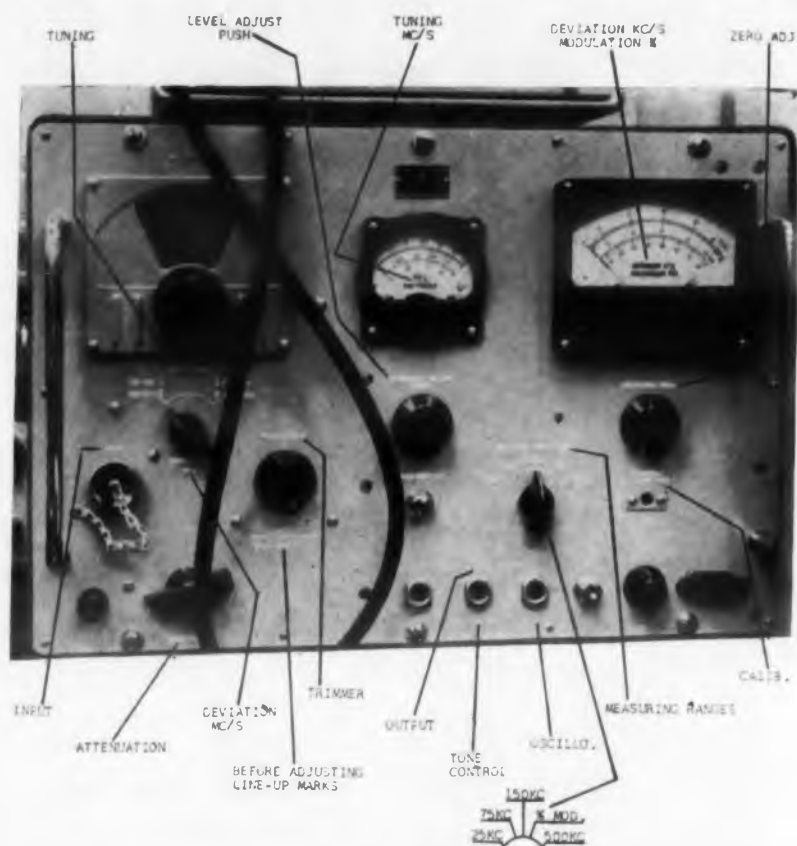
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## RUSSIAN TEST EQUIPMENT

### Modulation Meters (continued)

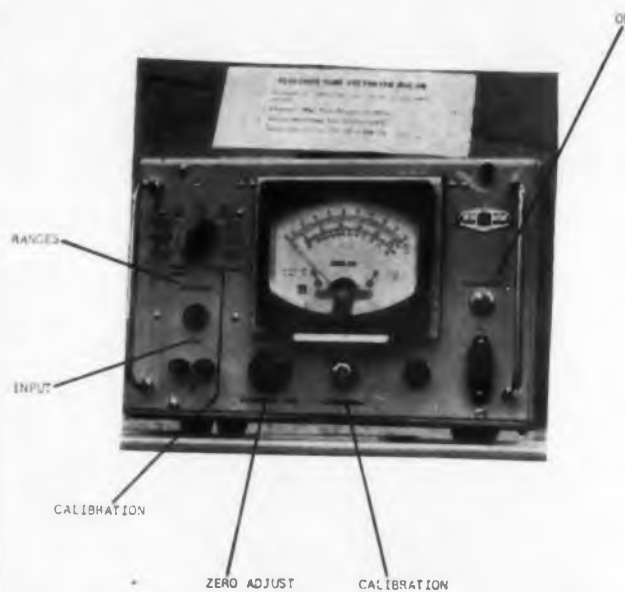


**Fig. 8.** Frequency Deviation Meter IDCH-1 measures frequency deviation of fm signals, modulation percentage of am signals, and frequency. Frequency range: 50 to 700 mc. Frequency deviation range: 2 to 500 kc. Modulating frequencies: 50 cps to 30 kc. Am-percentage measuring range: 10 to 80 per cent. Instrument sensitivity at least 20 mv.



**Fig. 8a.** General Radio. TV Transmitter Monitor 1184-A measures frequency deviation to higher frequencies than does the Russian equipment (to 890 mc to cover uhf channels), but it measures deviation to only 25 kc which is standard for TV in the U. S. Russian instrument appears somewhat more sensitive than G-R unit which is intended for EIA standard monitoring outputs.

## Voltage and Power Meters



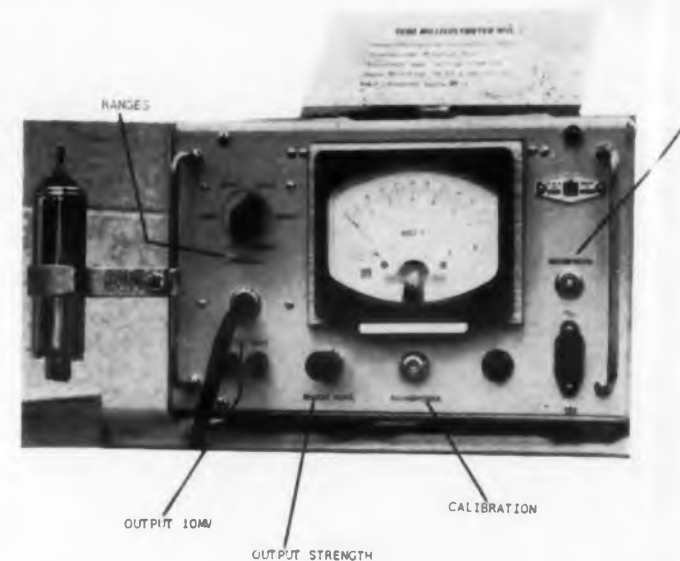
**Fig. 9.** Vacuum-Tube Voltmeter MVL-2M measures rms values of sine waves from 20 cps to 400 kc. Range: 10 mv full scale to 300 v.



**Fig. 9a.** Ballantine. Electronic Voltmeter 300D measures sine waves from 10 cps to 250 kc, a somewhat narrower range than the 20 cps to 400 kc of the MVL-2M. The Ballantine has a logarithmic scale which provides a uniform 2 per cent accuracy at any point on the scale.



**Fig. 9b.** Hewlett-Packard. AC Transistor Voltmeter 403A provides full-scale voltage readings from 1 mv to 300 v over the wide range of 1 cps to 1 mc.



**Fig. 10.** Vacuum Tube Millivoltmeter MVL-3 measures sinusoids from 10 mv full scale to 100 v. Frequency range: 30 cps to 10 mc.



**Fig. 10a.** Hewlett-Packard. Vacuum Tube Voltmeter 400H covers 1-mv to 300-v full-scale ranges from 10 cps to 4 mc (compared with 30 cps to 10 mc).



**Fig. 10b.** Ballantine. Electronic Voltmeter 314 measures 10 mv full scale to 100 v over a 15-cps to 6-mc range. Without the probe, the Ballantine's sensitivity extends to 1 mv full scale. Other Ballantine instruments cover frequencies from 0.01 cps to 6 mc.

### Aesthetics in Test Equipment Is Decadent in Russian View

When it comes to appearance design, said Donald Sinclair, technical director and executive vice president of General Radio Co., the Russians simply don't care. They don't style their equipment. Dr. Sinclair saw the Russian equipment at the New York show and saw many of the same instruments in Russia.

While representing the IRE (Dr. Sinclair was IRE president in 1952), at a meeting of the Russian Popov Society in May 1958, Dr. Sinclair had occasion to visit several Russian electronics plants and to talk with many Russian engineers. They told him that when it comes to instrument design, "... aesthetics for the sake of eye-appeal alone is decadent." They don't object to appearance design, Dr. Sinclair contended, if it will improve function, but they don't go for appearance design as an end itself.

### Equipment at New York Show Typical of What's in General Use

Equipment at the Russian Show in New York is typical of what they have around in their labs and in their plants. It is not necessarily their best, nor their latest, Dr. Sinclair told *ELECTRONIC DESIGN*. In addition to the general test equipment they showed, the Russians have lots of instruments to deal with specific situations.

Basic ideas for instrumentation come from medical, scientific and research institutes. Most decisions on what equipment will be built come from

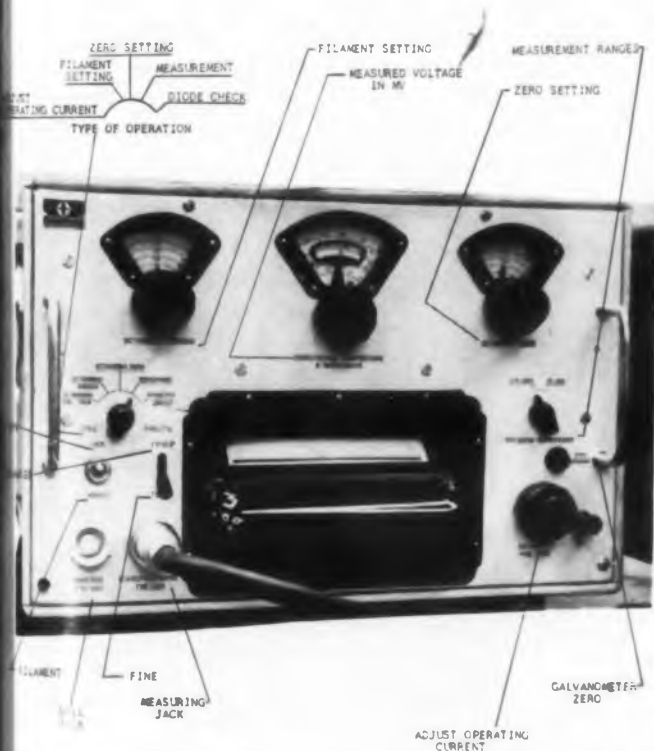
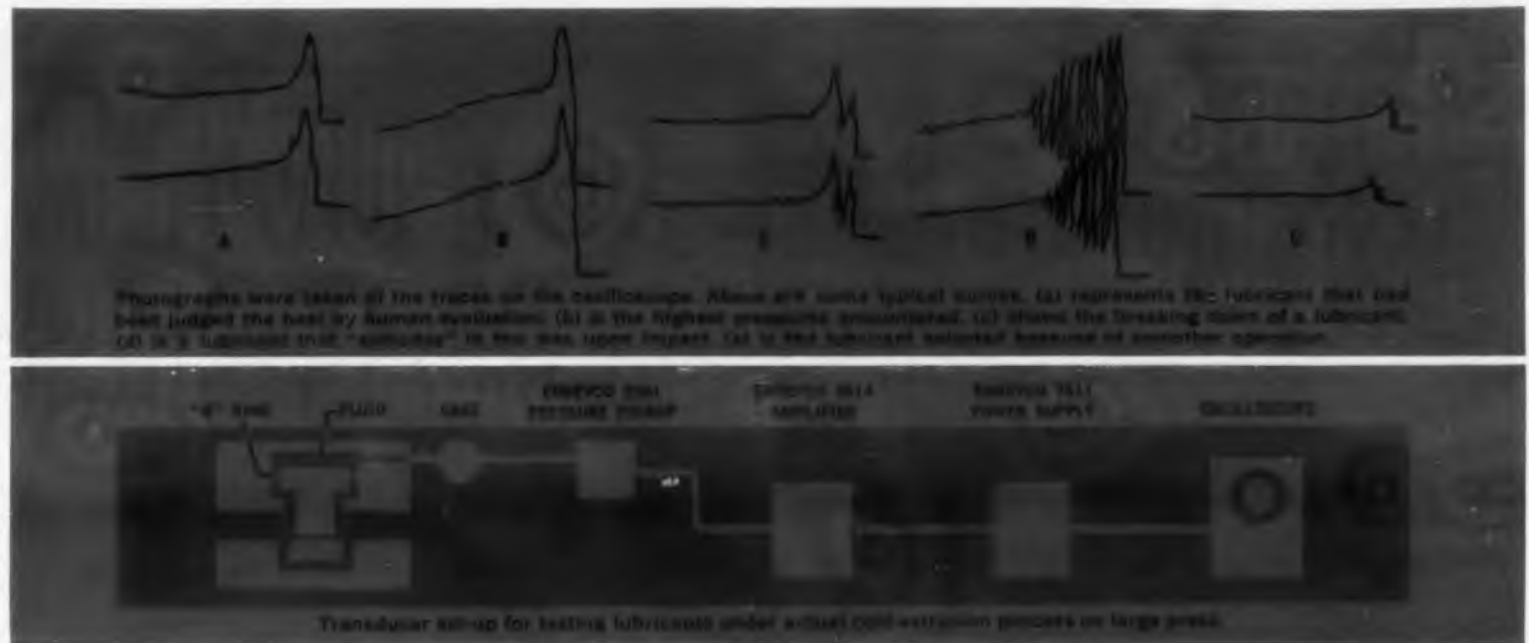


Fig. 11. Standard Electronic Voltmeter VLO-2 checks standard-signal generators and measures sinusoidal signals from 15 to 1250 mv. Frequency range: 100 to 1000 mc. Instrument is battery operated and appears to be slide-back type voltmeter.



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## RUSSIA TEST EQUIPMENT Voltage and Power Meters (continued)



**Fig. 11a.** Ballantine. A-T Voltmeter 390 uses a continuously adjustable waveguide-below-cutoff piston attenuator to feed a uhf thermocouple whose dc output is read on an auxiliary millivoltmeter. Unknown inputs from 0.5 to 300 v are determined by referring micrometer readings to a calibration chart. Useful from 10 to 1000 mc, the instrument is supplied with an auxiliary millivoltmeter, NBS certification, and calibration curves.



**Fig. 11b.** Ballantine. Micropotentiometer 440 is basically a low-source-impedance voltage source, useful from dc to almost 1000 mc. It has a uhf thermocouple whose dc output can be read on an external microammeter. Instrument can calibrate sensitive high-frequency voltmeters and, with an auxiliary transfer device, it can calibrate output levels of signal generators.



**Fig. 11c.** Hewlett-Packard. RF Millivoltmeter 411A uses chopper stabilization and a unique feedback system to provide a linear scale calibration from 5 kc to 1 kmc for full-scale voltage ranges from 10 mv to 10 v rms.

the State committee on radio and electronics (in which the Academy of Sciences has a strong voice). But the State does not decide on all equipment. If an engineer needs a specific type of equipment which isn't available, he may design and build it himself, just as he would in the United States.

#### Russians Use Brute Force Reliability Techniques

Russian approaches to reliability may not be as sophisticated as ours, and they may not have the mathematical and statistical finesse. But they are effective.

For reliability, we try to design our equipment with an *adequate* safety factor. They use very large safety factors. They might use a 2-w resistor where we would use a 1/2-w unit. They just don't cut corners. But our approaches to quality control and miniaturization, Dr. Sinclair stated, are far more sophisticated.

#### Will Copy Foreign Designs But Feel No Need to Now

Neither the Russians, nor the Chinese, nor any of the East European Communist countries have compunctions about copying foreign designs. Their attitude: "Why design from scratch? Why design a wheel again if somebody has already designed one?" When a situation calls for an instrument that somebody's already made, they won't bother designing anew. They'll copy the design directly. They might prefer buying the instrument, but trade restrictions often prevent this.

These restrictions are apparently effective. Dr. Sinclair saw no western equipment in Russia. He did see some equipment from East Germany and from Hungary.

In the past few years, according to Dr. Sinclair, the Russians have apparently seen no need to copy and have designed virtually all their own equipment. But there are still many examples of Communist-bloc instruments which are obviously copies of American units.

#### Chinese Copy Crackle-Perfect

An engineer who had been to Peiping told Dr. Sinclair of some Chinese engineers who were concerned about the faithfulness of their reproduction of the . . . 650A Impedance Bridge. They wondered if they had truly duplicated the G-R crackle finish.

#### "Casual" Observation Yields Insight to Technical Capability

David Packard, president of Hewlett-Packard Co., also saw Russian replicas of American equipment, including a copy of the H-P model 410 voltmeter. Mr. Packard toured Russia in August

(text continued on page 66)

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- Low Oxygen content  $1 \times 10^{17}$  per cc.,  $1 \times 10^{16}$  for special Knapic small diameter material.
- Doping subject to customer specification, usually boron for P type, phosphorous for N type.
- Lifetimes: 1 to 15 ohm cm.—over 50 microseconds; 15 to 100 ohm cm.—over 100 microseconds; 100 to 1000 ohm cm.—over 300 microseconds. Special Knapic small diameter material over 1000 microseconds.

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Dislocation density, Knapic silicon monocrystals grown by a modified Czochralski technique: Crystal diameter to 3/8"—None, 3/8" to 1/2"—less than 10 per sq. cm.; 1/2" to 3/4"—less than 100 per sq. cm.; 3/4" to 1"—less than 1000 per sq. cm.



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## RUSSIAN TEST EQUIPMENT

### Voltage and Power Meters (continued)

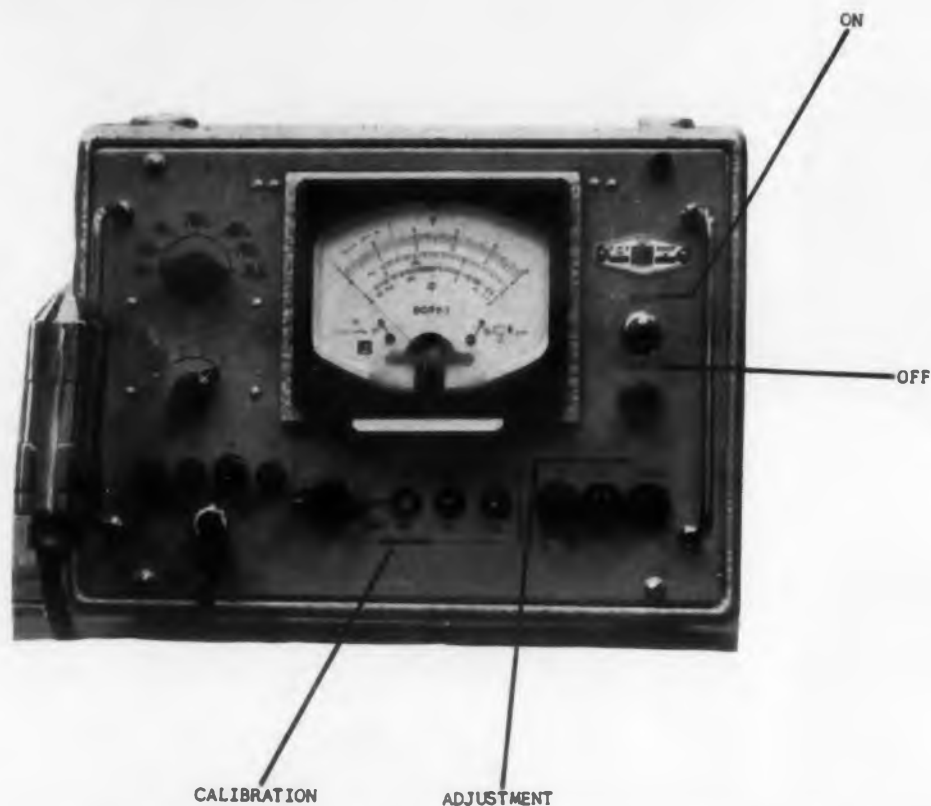


Fig. 12. Vacuum Tube Voltmeter VOLU-1 measures ac from 1.5 to 150 v full scale, dc from 0.5 to 500 v full scale, and resistance from 1 ohm to 50 meg. Frequency range: 20 cps to 700 mc.



Fig. 12b. Allen B. Du Mont. AC-DC Voltmeter 405 measures dc from 0.1 v to 1000 v full scale, and ac from 0.1 v to 300 v full scale from 50 cps to beyond 700 mc with appropriate probes. Voltages may be measured at either of two switch-selected input terminals. Circuit ground is isolated from chassis so differential voltage measurements can be made. Resistances can be measured from 0.5 ohm to 500 meg.



Fig. 12c. General Radio. Vacuum Tube Voltmeter 1800-B covers 0.5 to 500 v full scale for both ac and dc and provides about the same frequency coverage as Russian unit. The G-R instrument does not provide for direct resistance measurements. The 2 per cent accuracy of the 1800-B is better than the 3 per cent which is likely for the Russian instrument.



Fig. 12a. Measurements. Vacuum Tube Voltmeter 162 reads ac voltages from 1 v full scale to 300 v in the range from 20 cps to almost 350 mc. It reads dc from 1 v full scale to 1000 v and resistance from 0.2 ohms to 500 meg. On its most sensitive range, instrument can be used as a 0.01- $\mu$ a microammeter.



Fig. 12d. Hewlett-Packard. Vacuum Tube Voltmeter 410B provides full-scale readings of dc from 1 to 1000 v and ac from 1 to 300 v from 20 cps to 700 mc with an accuracy of 3 per cent. The 410B reads resistance from 0.2 ohm to 500 meg.

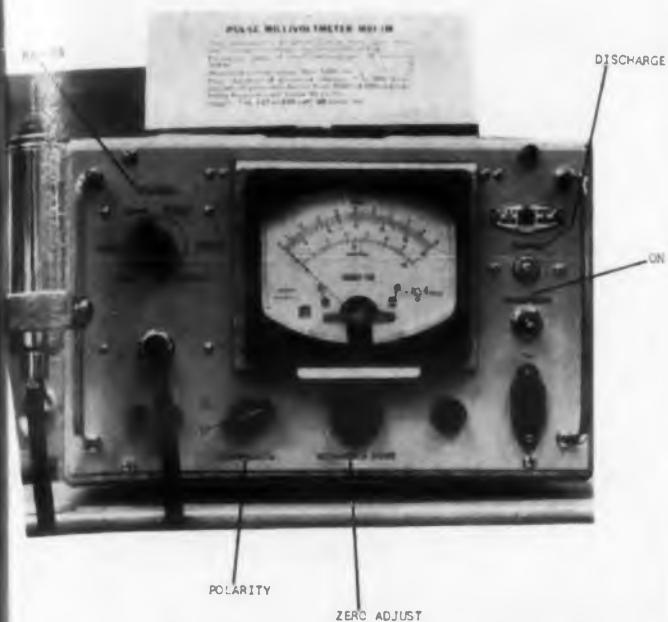


Fig. 13. Pulse Millivoltmeter MVI-1M measures pulse and sinusoidal voltage from 10 to 3000 mc full scale. Frequency range for sinusoids: 30 cps to 500 kc. Duration of pulses: 1 to 200  $\mu$ sec at 100 to 2500 cps. Measurement error does not exceed 4 per cent.



Fig. 13a. Ballantine. Peak Voltmeter 305A gives peak, or peak-to-peak readings of sinusoids from 5 cps to 500 kc and pulses with durations of 0.5  $\mu$ sec to 5 msec. Full scale readings, on logarithmic scales, are from 3.5 to 1000 v.

## SPERRY... new "first source" for critical semiconductor devices

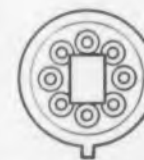
Sperry has become a new prime source for semiconductors because of its concentration on creating the most advanced devices in production quantities incorporating the highest quality and reliability. For example, Sperry was first to introduce a .5 amp silicon switching diode with .3  $\mu$ sec recovery time (Types 1N920 thru 1N923). Sperry is making substantial contributions in these other areas of semiconductor technology.

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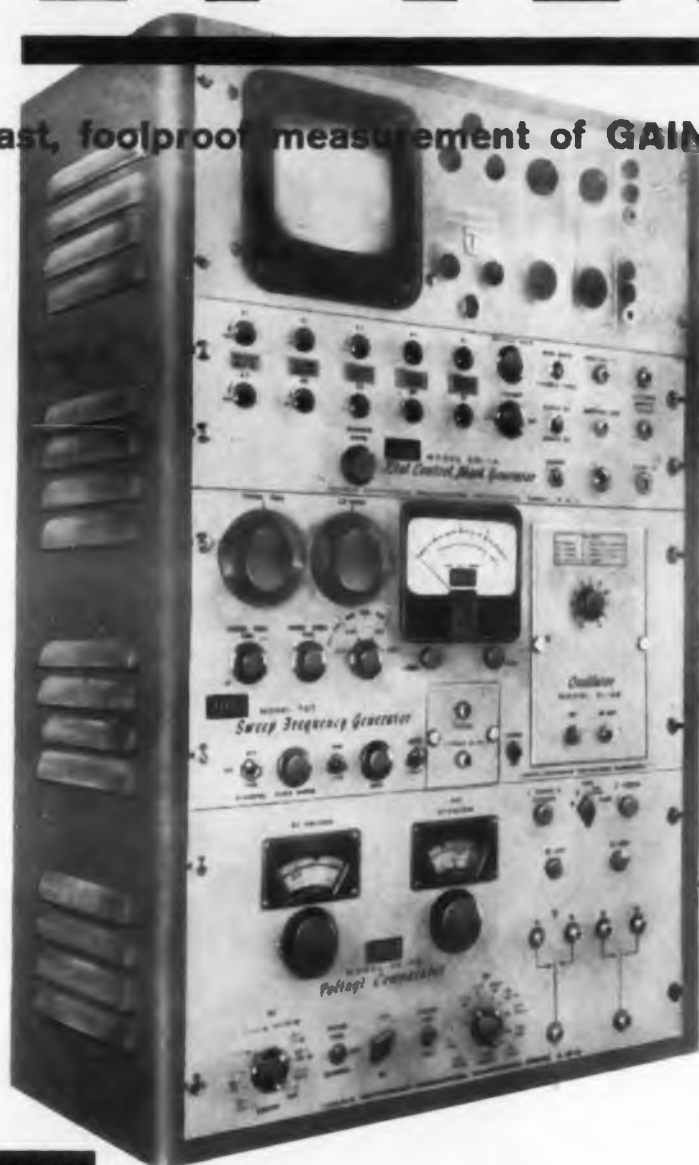
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(Oscilloscope, rack, or recorder not included)

## RUSSIAN TEST EQUIPMENT

Power and Voltage Meters (continued)

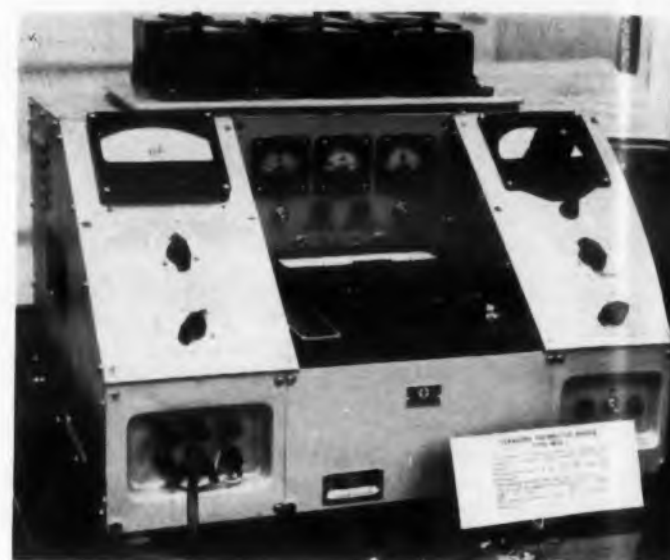


Fig. 14. Standard Thermistor Bridge MTO-1 measures low-power, high-frequency oscillations, when working with thermistor heads. Six ranges cover 15 to 5000  $\mu$ w. Reading settling time does not exceed 12 sec. Can be balanced for impedances between 75 and 400 ohms. Main indicator is precision light-point meter.



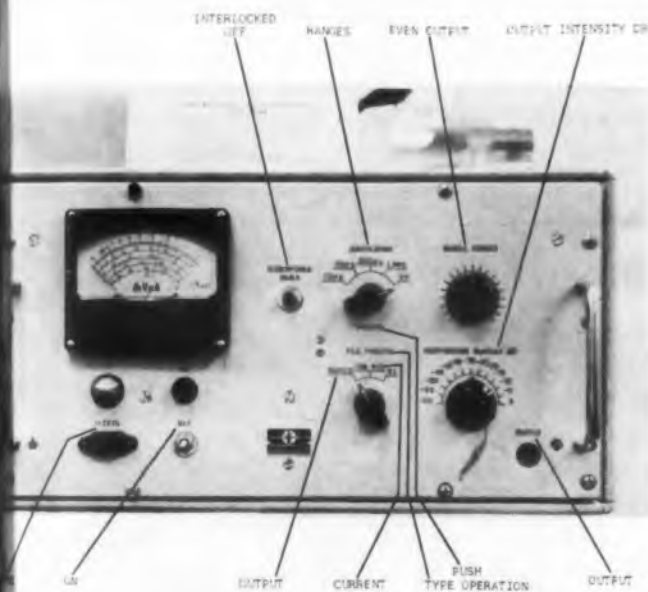
Fig. 14a. FXR. Power Meter B831A, with appropriate temperature-compensated thermistor heads, covers from 10 to 3000  $\mu$ w in six ranges compared with 15 to 5000  $\mu$ w for the MTO-1. The FXR instrument is far more compact than the Russian unit.

ELECTRONIC DESIGN • August 17, 1960



**Fig. 14b.** Polytechnic Research & Development. Universal Power Bridge 650-A, at maximum sensitivity (100  $\mu$ w) is much less sensitive than the MTO-1, but at minimum sensitivity it can measure higher power levels (100 mw compared with 5 mw). Setting time on the PRD instrument is virtually instantaneous compared with 12 sec for the Russian instrument.

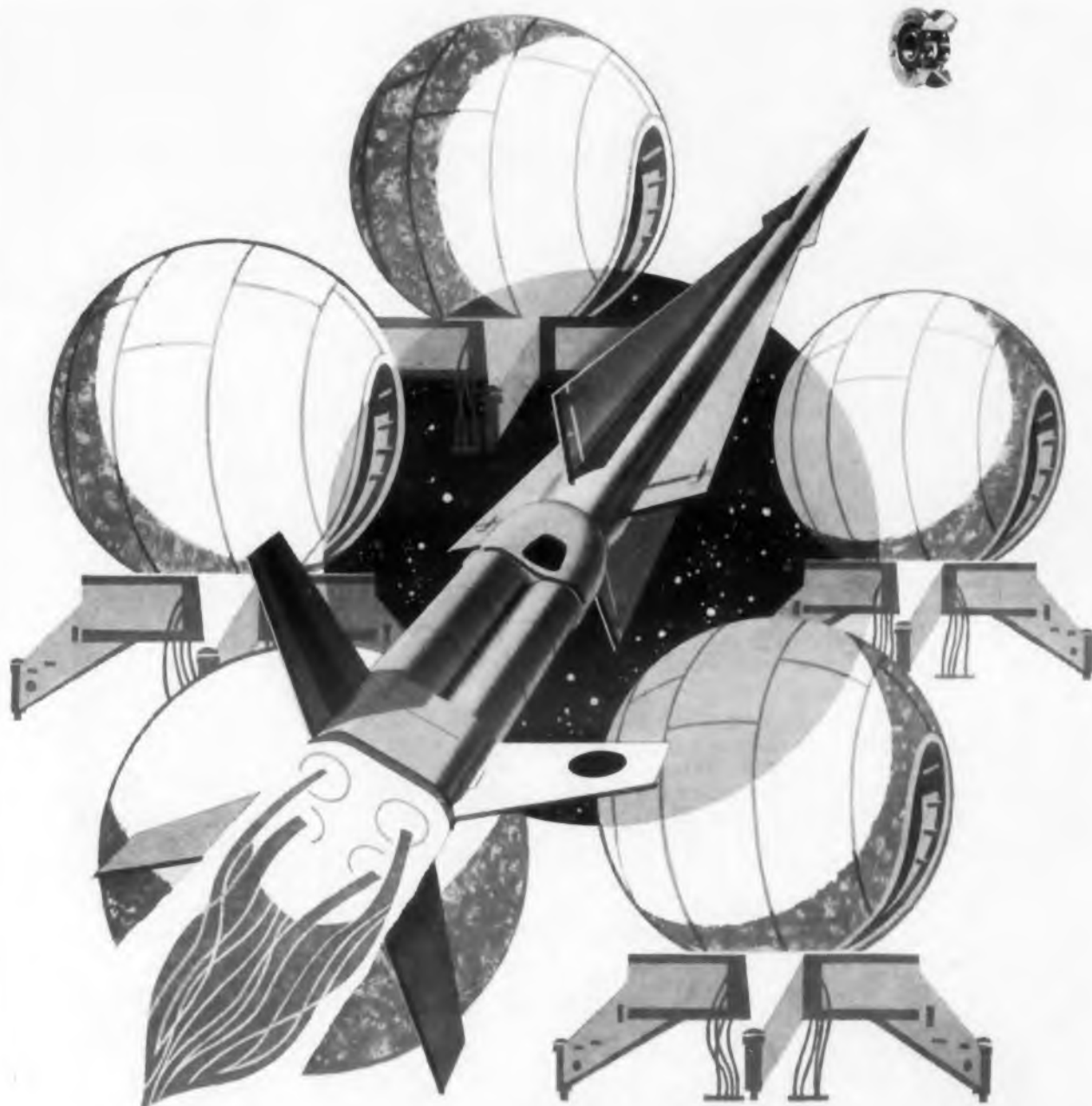
## Noise Instruments



**Fig. 15.** Low-Frequency Noise Generator GSHN generates white noise from 50 cps to 6 mc. Output: 0.75 v rms. Output impedance: 75 ohms  $\pm$  1 per cent.



**Fig. 15a.** General Radio. Random-Noise Generator 1390-B has wider frequency range and considerably higher output: 3 v to 20 kc, 2 v to 500 kc, and 1 v to 5 mc.



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A timely example of N/D customer assembly savings can be seen in Nike Ajax and Hercules missile ground support. Here, *special* N/D Instrument ball bearings are now used in precision potentiometers. New Departure engineers recommended eliminating two *single* row instrument bearings, mounted in duplex and requiring precision spacer and separate guide roller. They

replaced this assembly with a *special* N/D double row high precision instrument ball bearing with integral outer race guide roller . . . and shaft mounted with a nut. This one recommendation produced cost savings of over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's more, the New Departure Instrument Ball Bearings improved potentiometer reliability!

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## RUSSIAN TEST EQUIPMENT

### Noise Instruments (continued)

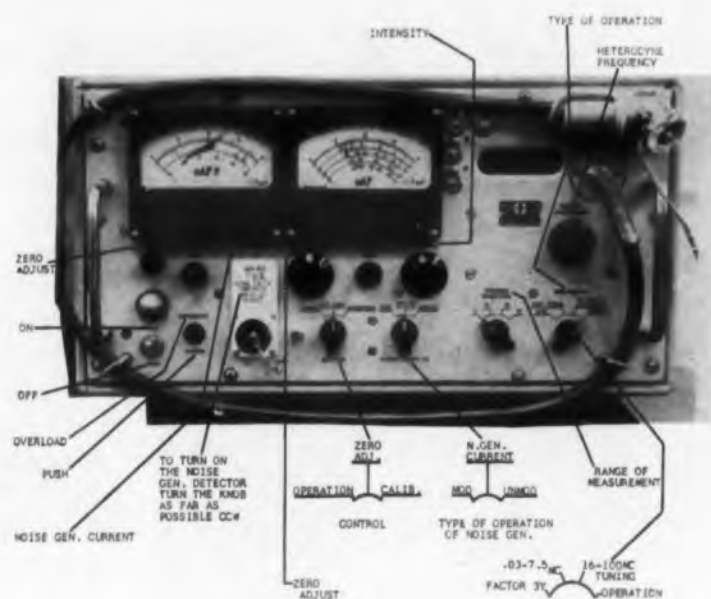


Fig. 16. Noise Factor Meter IKSH-1 measures noise factor of receivers and amplifiers. Frequency range: 30 kc to 100 mc. Standing wave ratio of generator output does not exceed 1.5. Noise figures from 1.76 to 30 db are measured.



Fig. 16b. Hewlett-Packard VHF Noise Source 343A generates noise over 10 to 600 mc range. Vswr is less than 1.1 from 10 to 400 mc and less than 1.3 from 400 to 600 mc.

Fig. 16c. Polytechnic Research & Development VHF-UHF Noise Generator 904 covers 30 to 1000 mc with maximum vswr of 1.3. Noise-figure range of 0 to 20 db is narrower than that of Russian unit but noise figures beyond 20 db can be calculated using PRD's instrument. PRD instrument has no restrictions on intermediate frequency or bandwidth.

1959 with 34 North California businessmen at the invitation of First Deputy Premier Mikoyan.

In his comments to *ELECTRONIC DESIGN*, Mr. Packard emphasized the fact that, at best, it is difficult to make accurate comparisons of test equipment without a comprehensive testing procedure and an extensive comparative evaluation. He insisted that his impressions of Russian instruments and technical capabilities are based on a relatively casual observation.

### Russian Equipment Adequate But Not Outstanding

In general the Russians seem to have an adequate selection of electronic test equipment. Most of their instruments are utilitarian in their design



Fig. 16a. Hewlett-Packard Noise Figure Meter 342A is used with a noise source. Frequencies: 30 to 200 mc. Range: 0 to 15 db with indication to infinity. Bandwidth: 1 mc minimum. Russian instrument appears to have facility for front-panel selection of any frequency within its range. Difficult to tell whether Russian unit is automatic. H-P unit can automatically measure and continuously display noise figure and can provide recorder output.



—free from frill—and probably quite adequate for most work. This, Mr. Packard put forth, tends to be characteristic of their entire industry.

A couple of instruments, he continued, were, without question, copies of instruments originally developed by Hewlett-Packard. They were not exact duplicates though. The Russians would design cabinets and mechanical features to fit their own manufacturing capabilities. Other instruments he saw were obviously original designs, made for specific purposes.

In no case did he see anything which he felt was an advance in technology beyond that in the United States. Most of the equipment was characteristic of devices designed here four or five years ago.

### Few Time-Saving Devices, No Automatic Testers

He saw little evidence of time-saving features and no automatic test equipment at all. None of their equipment showed consideration of what we call human engineering. There were some digital devices, but the use of digital presentation did not seem to be anywhere near as advanced as it is here.

This again, Mr. Packard asserted, characterizes much of their economy. Very few labor-saving

### Other Instruments

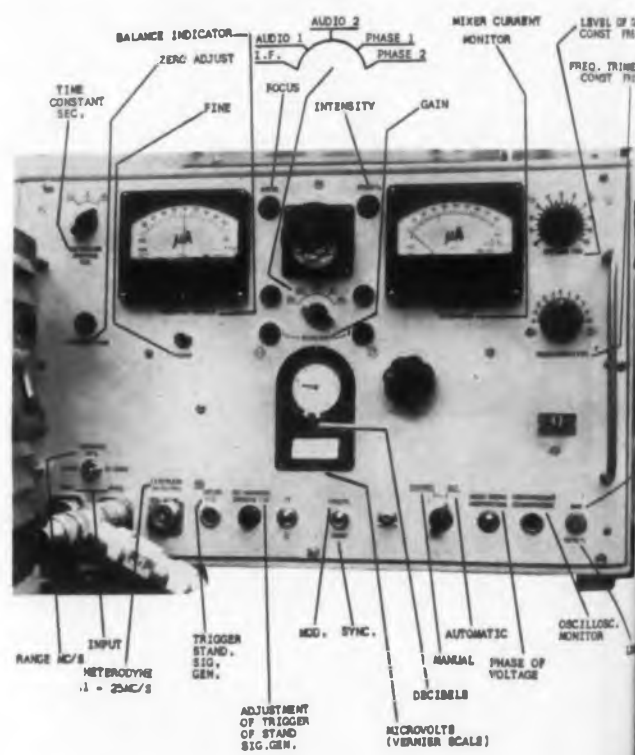


Fig. 17. Attenuator calibrator UKA-1 calibrates attenuators in standard signal generators as well as separate attenuators. Uses standard signal generator as signal source. Frequency range divided into two bands from 100 kc to 25 mc and 15 mc to 3 kmc. Characteristic impedance of mixer-head input is 75 ohms at frequencies higher than 15 mc. Standing wave ratio no worse than 1.2. Range of calibrated section of standard attenuator between 0 and 110 db. Minimum input signal 1.0  $\mu$ V across 75-ohm load.

devices were used anywhere. Hence, they have no unemployment and they are still working a seven-day week.

In visits to several factories, it appeared to Mr. Packard that the Russians had technical people who were competent and original and that they were emphasizing all types of instrumentation throughout their industry. They seemed to have a good selection of components including traveling-wave tubes and modern semiconductors.

However, their technical people did not have anywhere near as broad a selection of electronic measuring equipment as do ours because their systems lack the competitive drive.

#### Meter Factory Peens Coil Springs Rather Than Rolling Them

At a meter factory, Mr. Packard saw meter springs made by rolling beryllium copper wire into flat ribbons. The rolling machines, designed by the shop foreman and manufactured right at the plant, used two ball bearings for rollers. The wire was pulled between the bearings (which did not roll), so it was actually peened rather than rolled.

The Russians felt that peening provided a better spring than rolling. The entire production job seemed to be very carefully controlled.

#### Light-Beam Galvanometer Uses "Better" Feedback

At the same plant, they were manufacturing a light-beam galvanometer using a self-balancing technique similar to that used in dc amplifiers made by the Weston Instruments Div. of Daystrom. The Russians said they had worked out better feedback techniques than Weston was using, but they declined to give details.

#### Keen Interest Shown In American Equipment

The Russians expressed keen interest in American instruments though they claimed to have



Fig. 3. Waveguide Instrument Line LI-5 measures impedance, wavelength, and other waveguide parameters. Frequency range: 2.6 to 8.3 kmc. Vswr does not exceed 1.03 for one waveguide size, 1.05 for another.

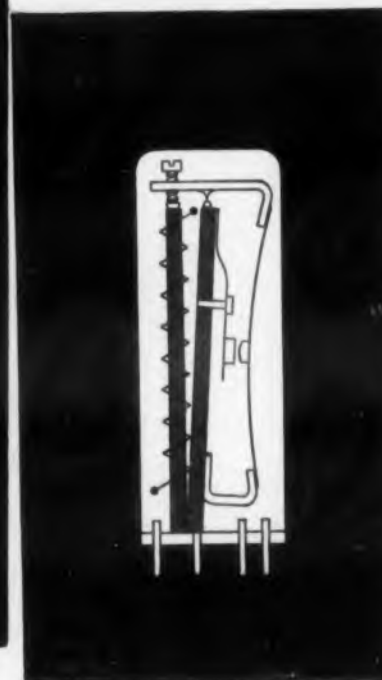


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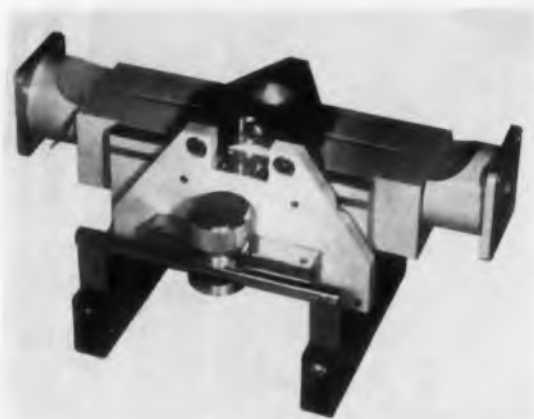
55 LAKESIDE AVENUE, WEST ORANGE, N. J.  
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## RUSSIAN TEST EQUIPMENT

### Other Instruments (continued)



**Fig. 18a.** Polytechnic Research & Development. Slotted Line 201-A covers 3.95 to 5.85 kmc with vswr of 1.01. Other lines available cover 2.6 to 8.3 kmc.



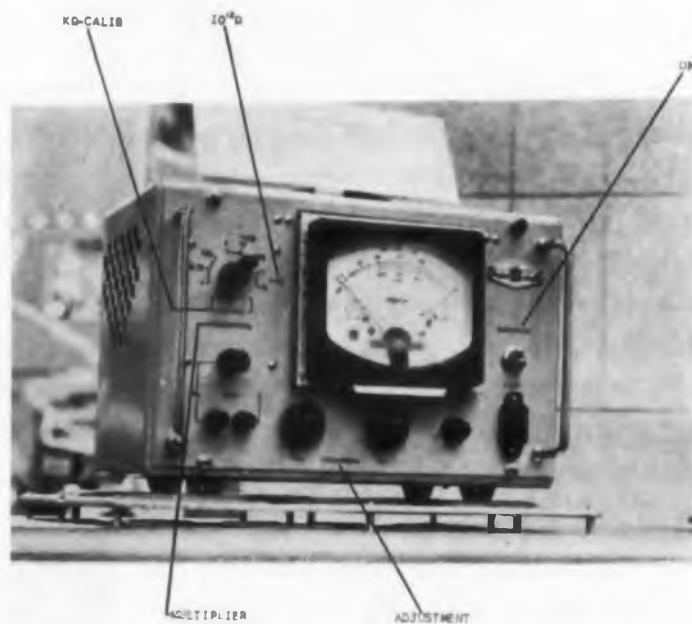
**Fig. 18c.** FXR. Precision Slotted Section H101A covers 3.95 to 5.85 kmc with vswr of 1.01. Series 101 covers 0.35 to 12.4 kmc.



**Fig. 18b.** Narda Microwave. Waveguide Impedance Meter 220 covers 8.2 to 12.4 kmc with vswr of 1.01. Others available from 2.6 to 18 kmc.



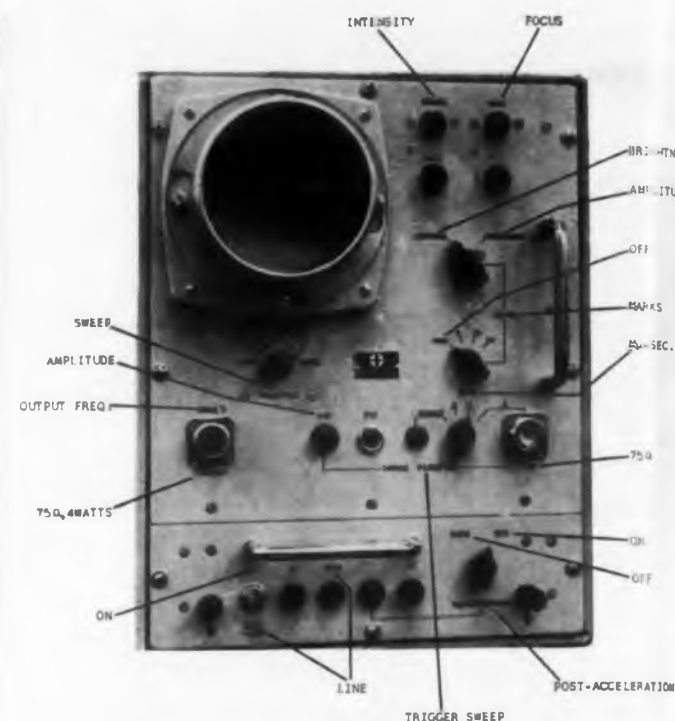
**Fig. 18d.** Hewlett-Packard. Waveguide Slotted Section S810A covers 2.6 to 3.95 kmc with vswr of 1.01.



**Fig. 19.** Teraohmmeter MOM-4 measures electrical resistance as well as volume and surface resistivities of insulation materials. Range: 2 K to  $10^{11}$  ohms.



**Fig. 19a.** General Radio. DC Amplifier and Electrometer 1230-A. Measures resistance from 300 K to  $5 \times 10^{14}$  ohms. Also measures voltage from 30 mv full scale to 10 v dc and currents from  $5 \times 10^{-15}$  amp to 1 ma dc. Also used as sensitive dc amplifier.



**Fig. 20.** High-Speed Oscillograph OC-4 has sweep durations from 10 to 1000 nsec. Maximum triggering frequency: 200 kc. Minimum sweep-triggering delay: 60 to 80 nsec. Sensitivity: 0.26 and 0.2 mm per volt. Line width: 0.3 to 0.5 mm.



**Fig. 20a.** Allen B. Du Mont. High-Frequency Oscilloscope 410 provides sweep durations from 0.1 usec to 200 msec, and sensitivity to 20 cm per volt. Fastest sweep speed on Russian instrument is about 10 times faster than that on the 410. Du Mont unit has about 1000 times stated sensitivity of Russian unit. Du Mont scope can be triggered at 250 kc. Both instruments have 4-w input attenuators, the Du Mont at 50 ohms, the Russian at 75 ohms.

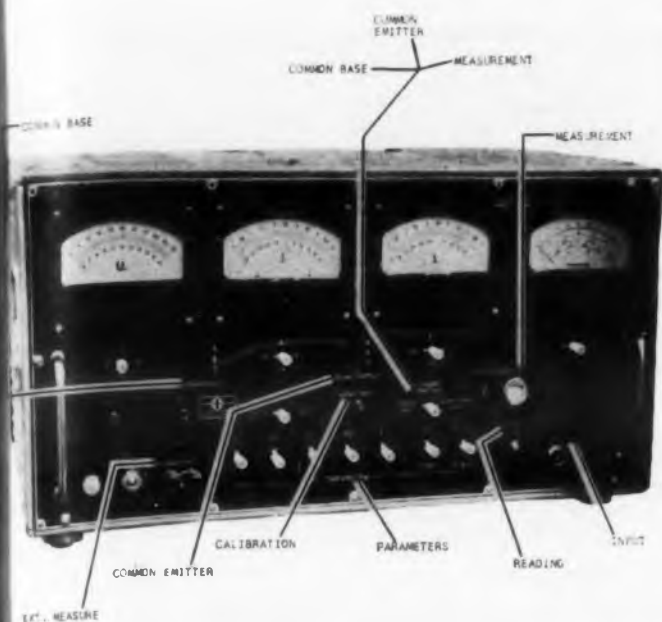


Fig. 21. Transistor Tester IPPT-1 measures parameters of low-power, junction-transistor triodes. Measurements are conducted at 270 cps, 465 kc and from 100 kc to 10 mc.



Fig. 21a. Boonton Radio. Transistor Test Set 275-A uses a null-type readout which affords better than 1 per cent accuracy. The Russian unit uses conventional meter readout which may offer accuracies of only 10 per cent. The Boonton unit can measure transistors with emitter currents as high as 5 amps.

more sensitive instruments than we do. They told Mr. Packard that they had a dc galvanometer with 1-1/2- $\mu$ v sensitivity but they didn't have any available to show him. The most sensitive galvo he could see in their catalog or among their samples had a 150- $\mu$ v sensitivity.

#### Meter Manufacturing Plant Makes Electric Razors, Too

Production procedures at another meter factory also seemed to assure a quality product. In this second plant, Mr. Packard saw a part of the plant devoted to assembly of electric razors. Apparently, it had been officially decreed that every factory in the Soviet Union had to make a product for the civilian economy. ■ ■



#### RCA-50EH5—

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Many design features contribute to the high performance of the 50EH5. New cathode base material minimizes inter-element leakage, cuts noise and hum, prolongs life and improves reliability. Improved heater material extends heater life. Special plate material minimizes gas-current runaway. And *EVERY RCA-50EH5 is thoroughly tested* for power output, hum, noise, shorts and continuity, emission and gas.

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Soviet Engineer A. V. Gorokhovsky Looks at

## Russian РУССКОЕ Electronic ЭЛЕКТРОННОЕ Test ИЗМЕРИТЕЛЬНОЕ Equipment ОБОРУДОВАНИЕ

*In "Russian Test Equipment and Ours" in this issue, readers will find views on Russian test equipment by leading American test-equipment manufacturers. To give readers "the other side" of the picture, ELECTRONIC DESIGN commissioned Soviet engineer Anatoli V. Gorokhovsky to present his views on the equipment available to Russian engineers. Here they are.*

**P**OST-WAR years have seen Soviet electronics make big strides. There has been a substantial increase in the manufacture of a variety of electronic equipments and components. New vacuum tubes, new transistors, and new materials have been developed for industry.

The Soviet radio engineering industry has an army of skilled specialists and a wide network of research establishments. Soviet electronics specialists have contributed much to the Soviet Union's earth-satellite effort and to its space-rocket and ballistic-missile programs. Not to be neglected is their role in designing the world's largest 10-bev proton synchrotron. Indeed, electronics is omni-present in the Soviet Union today. It serves science, technology, medicine, agriculture, and transport. Electronics shoulders a good portion of the process automation load, too.

Very little advance could have been made by electronics without the extensive use of different measuring instruments at all stages from research to manufacture to actual operation. For, today as

never before, the engineering standards of measuring facilities determine the quality of the finished product and the speedy development of new systems, tubes, semiconductors, and other components. Under the current Seven-Year Plan, test equipment output is to increase 2.5 to 2.6 times the output in 1958.

In 1958, about 200 types of general-purpose radio measuring instruments were produced in quantity. The number of producible types is continually growing. Soviet research institutes are conducting an extensive program under which new techniques and improved systems of measurement are being developed.

Brief technical data are given here on some of the general-purpose measuring instruments produced by the Soviet industry in quantity.

### Pulse Generators

The PNT-3M pulse oscillator (Fig. 1) is used for adjusting and testing a variety of pulse and broadband circuits. It can be used for tuning TV

sets in the shop and at home. It can be used to adjust if amplifiers of both picture and sound channels; to tune discriminators and limiters, to estimate a set's sensitivity; and to tune the tuner and sweep generators.

Frequency characteristics and waveforms can be observed on the crt in the instrument. The instrument produces fm oscillations in four ranges: 6-9, 27-70, 68-102, and 174 to 232 mc. When internally triggered, the instrument can generate pulses at repetition rates of 10 cps to 100 kc. It can be operated in the single-phase or repetitive mode.

In the latter case, the oscillator is triggered by pulses of either polarity with 0.1 to 10  $\mu$ sec duration and 10 cps to 100 kc repetition rate, or by sine waves from 20 cps to 100 kc.

Pulse generator MGI-1 (Fig. 2) generates positive or negative pulses whose amplitudes can be varied from 10 to at least 60 v. Pulse frequency (250 cps to 10 kc) can be smoothly changed and pulse duration can be adjusted in 0.1  $\mu$ sec steps.



Fig. 1. Pulse generator PNT-3M, principally a serviceman's tool, generates frequency-modulated oscillations from 6 to 232 mc.



Fig. 2. Pulse generator MGI-1 generates 0.1 to 10- $\mu$ sec wide pulses over a pulse repetition range from 250 cps to 10 kc.

from 0.1 to 10  $\mu$ sec. The generator also provides sync pulses 0.3 to 1  $\mu$ sec long.

The output can be smoothly delayed, relative to internal or external trigger pulses, from 20 to 70  $\mu$ sec. The external trigger must have a duration of at least 0.5  $\mu$ sec and a frequency of 300 cps to 10 kc. Sine waves in this frequency range can also be used as triggers.

#### Sine-Wave Generators

The GSS-27 standard-signal generator (Fig. 3) covers 2 to 3.8 kmc with a frequency error of no more than 1.5 per cent. A built-in wavemeter allows one to determine the frequency to within 0.2 per cent. The instrument has a milliwatt output (no less than 30 mw) and a calibrated microwatt output from  $10^{-8}$  to 100  $\mu$ w.



Fig. 3. Signal generator GSS-27 generates frequencies from 2 to 3.8 kmc with a frequency accuracy of 1.5 per



Fig. 4. Power meter IBM-2 measures pulse-power levels from 0.5 to 500 kw over a 30 to 1000-mc range.

The instrument can be internally modulated by an internal sawtooth (100 cps to 4 kc), by internal pulses (100 cps to 4 kc) with durations from 0.6 to 10  $\mu$ sec, and by an internal 1-kc sine wave. It can be modulated by external pulses from 10 cps to 10 kc with durations from 1 to 20  $\mu$ sec.

The GSS-15 standard-signal oscillator<sup>1</sup> is available in two versions, one operating between 150 and 1000 mc, and the other between 1 and 2 kmc. Its basic frequency error does not exceed 1 per cent. It has a built-in wavemeter which covers 1 to 2 kmc.

The instrument has two outputs: a high-power

<sup>1</sup> The GSS-15 is shown as Fig. 5 in "Russian Test Equipment and Ours" in this issue.

adjustable output providing at least 1 w and a microwatt output, calibrated from  $10^{-4}$  to  $10^{-14}$  w. The unit provides continuous oscillation, external am, external modulation by pulses 1 to 20- $\mu$ sec wide with rates of 100 cps to 10 kc, and internal modulation by 1 to 10- $\mu$ sec wide pulses with repetition rates from 100 cps to 2 kc.

The GSS-6A is a relatively unsophisticated standard signal oscillator covering 100 kc to 25 mc. Frequency calibration is to within 1 per cent.

The 641 is a beat-frequency audio oscillator operating to 5 kc. Frequency can be read at 0.5 cps intervals.

#### Frequency and Phase Meters

Type 44-1 precision wavemeter measures frequency between 8.9 and 10 kmc to within 0.003 per cent.

The SHGV-S broadband, heterodyne wavemeter measures frequency from 2.5 to 18 kmc to within 0.05 per cent. Maximum sensitivity is 0.1 mw.

The I4-6 frequency meter works in the audio and ultrasonic range from 10 cps to 200 kc.

The NF-2 phase-frequency meter measures the period and phase shift of sine waves, as well as pulse-to-pulse time intervals, and numbers of pulses. Its period and phase-shift accuracy is 0.5 per cent.

In addition to these, there is a wide selection of square-wave oscillators, video oscillators, sweep generators, noise generators, crystal oscillators for calibration, and oscillators for measuring crosstalk attenuation.

The ID4-1 measures frequency deviation from 1 to 150 kc of frequency-modulated oscillators operating from 100 to 700 mc.

The IM-19<sup>2</sup> covering 80 kc to 180 mc, calibrates internal modulation meters of signal generators, measures frequency deviation of fm signals, and determines per cent modulation of weak am signals.

#### Voltage and Power Meters

Type MVI-1M pulse millivoltmeter<sup>3</sup> measures small-amplitude video pulses of both rectangular and sinusoidal shape. It has six full-scale ranges with full-scale readings from 10 mw to 3 v. With an external voltage divider, the upper limit can be extended to 300 v. The instrument measures pulses with durations from 1 to 200  $\mu$ sec at 100 to 2500 cps with an error not exceeding 4 per cent.

The MVL-2M vacuum tube millivoltmeter<sup>4</sup>

<sup>2</sup> The IM-19 is shown as Fig. 7 in "Russian Test Equipment and Ours" in this issue.

<sup>3</sup> The MVI-1M is shown as Fig. 13 in Russian Test Equipment and Ours" in this issue.

<sup>4</sup> The MVL-2M is shown as Fig. 9 in "Russian Test Equipment and Ours" in this issue.





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Fig. 5. Dual-beam oscilloscope DESO-1 has a vertical pass band of 30 cps to 60 mc with a minimum sensitivity of 13 mv/mm.

measures rms values of voltages from 20 cps to 400 kc on full-scale ranges from 10 mv to 300 v. The instrument includes a decibel scale.

The VLCH-2 is a universal ac-dc vtvm covering the range to 400 mc.

Type IBM-2 power meter (Fig. 4) measures power levels of high-power, high-frequency pulses and provides an equivalent load. The instrument covers 30 to 1000 mc and 0.5 to 500 kw.

#### Other Instruments

The dual-beam, high-speed oscilloscope DESO-1 (Fig. 5) has a vertical passband of 30 cps to 60 mc and a sensitivity of at least 13 mv/mm. It can be used for 0.5 to 250 v pulses with pulse widths from 0.04 to 300  $\mu$ sec.

The ASCHX-1 spectrum analyzer (Fig. 6)



Fig. 6. Spectrum analyzer ASCHX-1 analyzes cw signals from 20 cps to 20 kc.



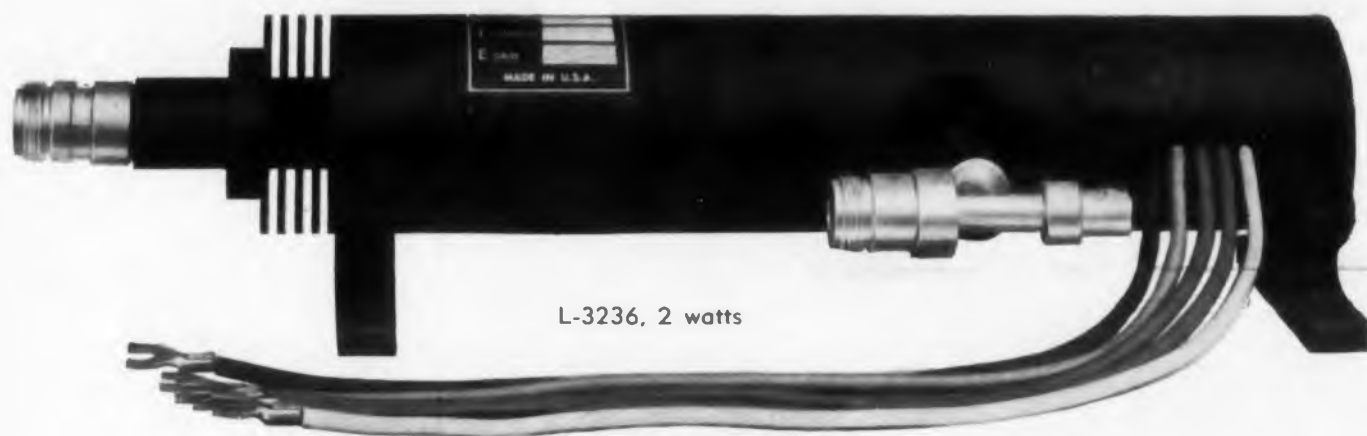
Fig. 7. The Pimel measures the interelectrode capacity of vacuum tubes.

shows the frequency response and spectra of cw signals from 20 cps to 20 kc. Its resolution is 12 cps in the range from 20 to 500 cps and 400 cps in the remainder of the instrument's range.

The UR-4 is a distributed amplifier for short pulses or high-frequency sine waves. Its pass-band is from 5 kc to 150 mc.

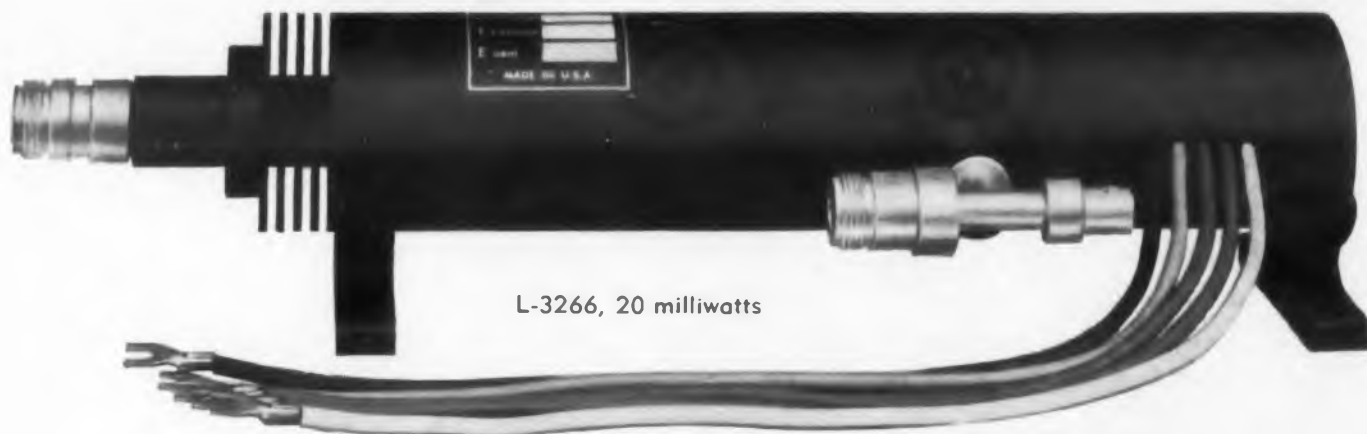
The Pimel (Fig. 7) measures interelectrode capacities of vacuum tubes. It comprises a bridge circuit, a high-frequency generator and a selective balance indicator.

At the lower end ( $10^{-4}$  to  $10^{-3}$  pf) of its five ranges, error in measuring capacitance doesn't exceed 5 per cent. From  $10^{-3}$  to 0.1 pf, the error does not exceed 2 per cent. And at the upper end of the range, from 0.1 to 50 pf, the error is no more than 1 per cent. ■ ■



L-3236, 2 watts

# TWT TWINS



L-3266, 20 milliwatts

These Litton TWT twins are PPM focussed X-band traveling wave tubes. They are *not* prototypes. They are metal and ceramic tubes in field application *now*.

Designed to cover X-band with minimum saturated CW power of 20 milliwatts (L-3266) and 2 watts (L-3236), they may be operated in cascade to amplify signals as small as  $-50$  dbm to the 2 watt level. Their performance, far exceeding the conservative specifications, is evident in the accompanying graphs.

Small size (less than 12" in length), light weight (under 4 pounds each), and extreme environmental capability (temperature compensated  $-54^{\circ}\text{C}$  to  $86^{\circ}\text{C}$ ) make these tubes the ideal choice for military applica-

tions. A typical airborne equipment, designed and manufactured by Granger Associates of Palo Alto, California, incorporates the L-3266 and L-3236 and occupies only 0.75 cubic feet, including all necessary power supplies, modulating circuitry, cooling, etc. This equipment is now in field operation.

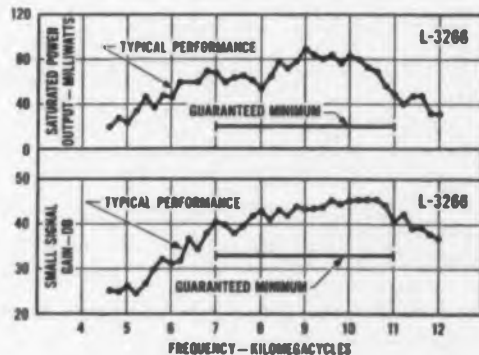
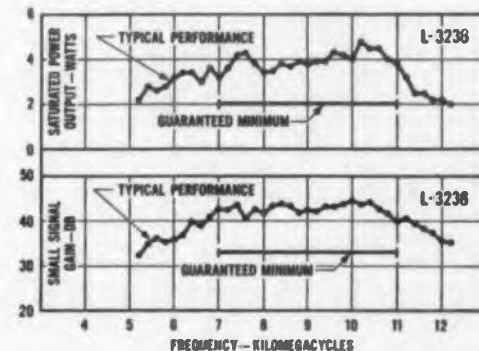
If your work involves ECM repeaters, radar target enhancement, frequency diversity radar or any application requiring broadband microwave amplifiers, appraise these new tubes. In production quantities their price is the lowest in the field. Ask for catalog sheets on the L-3266 and L-3236. Address: Litton Industries Electron Tube Division, 960 Industrial Road, San Carlos, California.

(see them at WESCON)



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## Microminiature Silicon Mesa Transistor Increases Power Output by 50 Per Cent

SEMICONDUCTOR device miniaturization, although far from a "scaling down" project, generally results in a decreased power dissipation rating. In contrast, a microminiature silicon mesa transistor, equivalent to the type 2N697, has been made available with 50 per cent higher power dissipation than its seven-times larger counterpart.

Designed for use in high-density applications, the Microbloc RT697M is virtually a solid block of silicon crystal imbedded in a gas tight, welded-seal package that is essentially all heat sink. The solid round header is highly resistant to thermally induced deformation which represents a major cause of lead bond failure. Other design advantages reported by Rheem Semiconductor Corp., Mountain View, Calif., include improved protection against lead shorting on the device under acceleration in any plane, protection against welding flash and a guaranteed hermetic seal. Units must pass a helium leak test at  $1 \times 10^{-10}$  cc/sec and ten cycles of mois-

ture resistance per MIL-S-19500B. In addition, each transistor is tested to withstand 1500 g shock and 20,000 g acceleration. Switchback voltage is 35 v, with base open.

Despite the low weight (0.25 gm compared to 1 gm for the conventional 2N697) and small size (only 0.063 in. high by 0.211 in. in diameter), handling of leads and soldering techniques do not differ from normal production practices used with the larger TO-5 and TO-18 packages. A cut-away section of a Microbloc unit is shown in Fig. 1; the electrical characteristics are presented in Table I.

The RT697M, first of a line of microminiature silicon mesa transistors, is priced at \$75 each in quantities of 1-99 and \$50 each in the 100-999 range. It is expected that the device cost will become competitive with the conventional size units in the fall, when mass production is underway.

For further information on this new device, turn to the Reader-Service Card and circle 250.

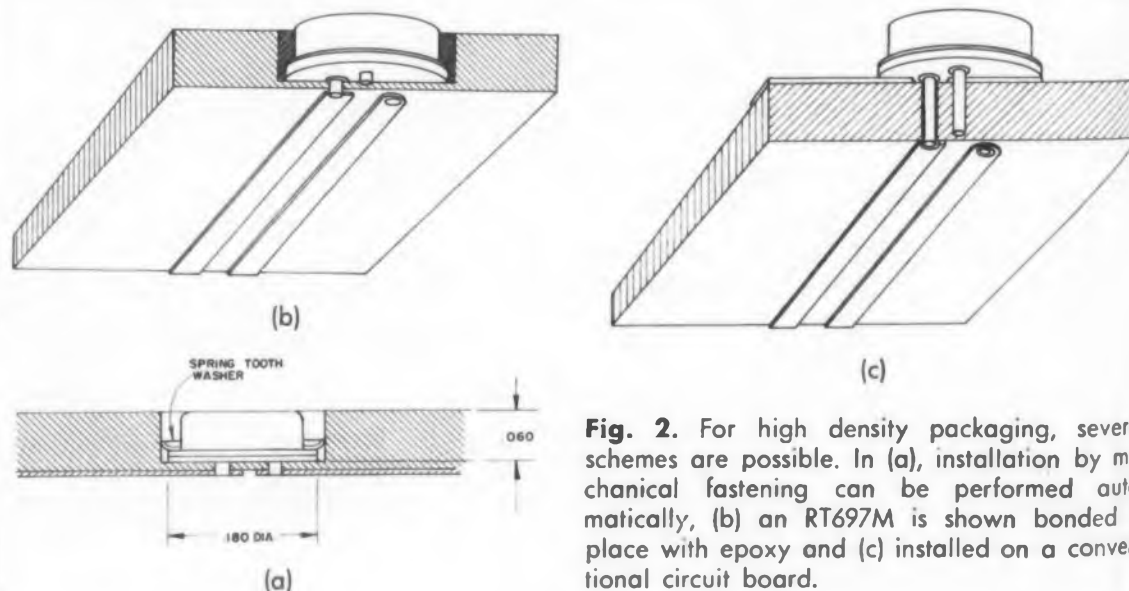
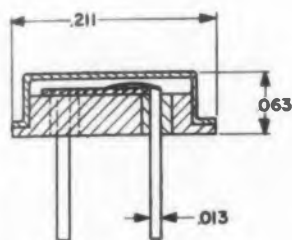


Fig. 2. For high density packaging, several schemes are possible. In (a), installation by mechanical fastening can be performed automatically, (b) an RT697M is shown bonded in place with epoxy and (c) installed on a conventional circuit board.



**Fig. 1.** Although seven times smaller than a conventional 2N697, the Microbloc device has a 50 per cent greater power dissipation due to the shorter metal path to the heat sink.

**Table 1. Electrical specifications for the RT697M microminiature silicon mesa transistor.**

**Maximum Ratings and Electrical Characteristics for Microbloc RT697M Maximum Ratings at 25 C Ambient (unless otherwise noted)**

Collector—Base Voltage	60 v
Collector—Emitter Voltage (Base Open Circuit)	35 v
Emitter—Base Voltage	5 v
Total Device Dissipation (at case temperature 25 C)	3 w
Operating Temperature Range	-65 to +175 C

**Electrical Characteristics at 25 C (Typical values unless otherwise noted)**

$I_{CBO}$	0.005 $\mu$ a (typ)
$I_{EBO}$	1 $\mu$ a (typ)
$BV_{CBO}$	60 v (min)
$BV_{EBO}$	5 v (min)
$h_{FE}$	75 (typ)
$V_{BE(sat)}$	95 v (typ)
$V_{CE(sat)}$	0.7 v (typ)
$h_{ie}$	5 (typ)
$C_{cb}$	20 pf (typ)

**Small Signal Parameters**

$h_{fe}$	70 (typ)
$h_{ie}$	26 ohm (typ)
$h_{re}$	$160 \times 10^{-6}$ (typ)
$h_{oe}$	0.2 $\mu$ mho (typ)



Ancient Egyptian artifacts from University of Nebraska State Museum

## INHERENT STABILITY Assured in a DALOHM RS Resistor

IN-HER-ENT, *adj.* Firmly infixed; esp., involved in the essential character of anything.

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their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

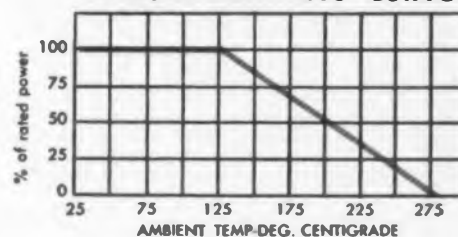
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Configurations: Type RS with radial leads and in most ratings and resistances shown; Type RLS with axial leads for printed circuits, and Type RSE for clip mounting.

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## One Machine Combines Induction Motor And Wide-Range Speed Controller

**A** COMPACT, combination induction motor and speed-control device allows the motor speed to be varied from zero to twice synchronous speed while maintaining constant torque. In addition, the speed is independent of power supply frequency.

The machine, invented by Andrew Bekey, of Los Angeles, and manufactured by Bekey Electric, Los Angeles, consists of four, three-phase windings arranged as shown in Fig. 1.

Portion A of the device and portion B each may be regarded as a wound-rotor induction motor. The positions of the control oscillator and the power supply may be interchanged without impairing the device's operation.

Mechanically, the device has a stator, member 13, a freely rotatable member, 18 (on which two of the four windings are mounted) and a rotor, 23, with its drive shaft, 25. The windings fed by the power source are called the primary windings; the windings fed by the control oscillator are called the secondary windings.

The secondaries are connected so they

produce magnetomotive forces rotating in the air gaps 20 and 24 in the same direction. The primaries are connected to produce oppositely rotating magnetomotive forces in the air gaps.

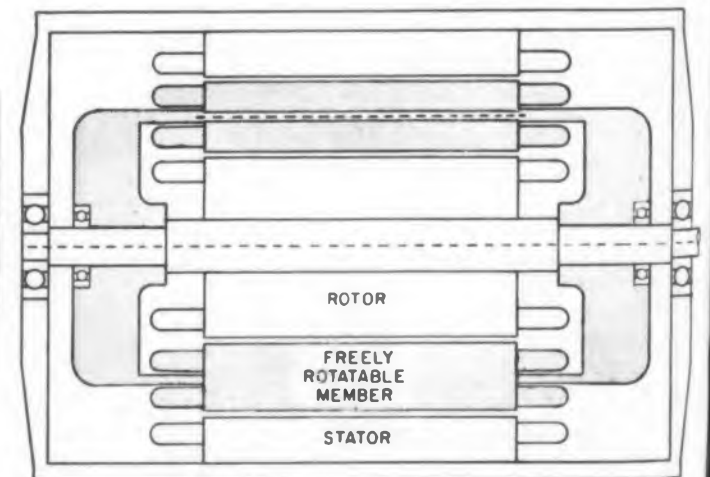
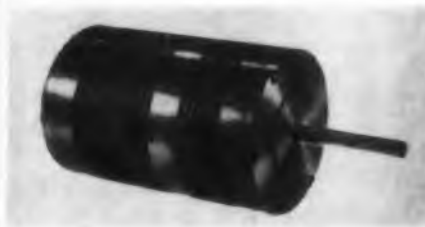
Assuming the primary and secondary magnetomotive forces are in the same direction in air gap 20, and in the opposite direction in air gap 24, the speed of the rotor with respect to the stator is twice the speed of the magnetomotive force wave due to the stator. This magnetomotive force speed is:

$$N = 120 f/p$$

where  $f$  is the frequency of the control oscillator and  $p$  is the number of poles on the winding.

Therefore the rotor speed, with respect to the stator, is  $2N$  or  $240 f/p$ . Hence, the speed of the drive shaft depends only on the frequency of the control oscillator.

Under load conditions, either A or B operates as an alternator while the other operates as a motor, depending on the relative directions of the primary and secondary magnetomotive forces in the gaps.



The variable speed motor (left) and schematic representation of construction features of the machine. Windings are concentric with respect to drive shaft so that air gaps are radial rather than axial.

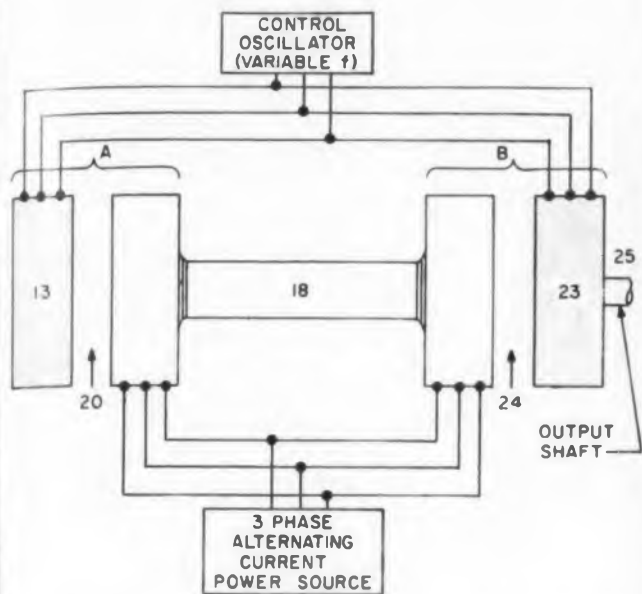


Fig. 1. The variable speed induction motor has four windings: a stator, 13, a freely rotatable member with two windings, 18, and a rotor, 23. Speed is varied by changing frequency of control oscillator.

Thus, this device combines in one machine the commonly used principle of controlling an induction motor's speed by coupling it to generating machinery that returns energy to the power lines.

In practice, the air gaps are not axial but are radial—that is, the windings are concentric. This permits a more compact construction for a given rating than would be possible with axial air gaps.

The three-phase control oscillator should be capable of delivering up to 3 amp at 110 v, and having its frequency variable between zero and the power line frequency. Electrical power is put into and removed from the windings through the usual slip-ring arrangement.

The motors come in custom built sizes up to 10 hp. They can be adapted for use at any convenient voltage and frequency, although it is expected they would be used primarily at 110 v and 60 or 400 cps.

Maximum speed is 1,200 rpm. The motor's dimensions increase with horsepower—the 10-hp motor has a 2-ft diam; the one-eighth-hp motor is 7 in. long by 4 in. in diameter.

Delivery time is eight weeks for new orders, and a month for repeat orders.

For more information about the motor, turn to the Reader-Service Card and circle 251.

# AB<sub>1</sub>



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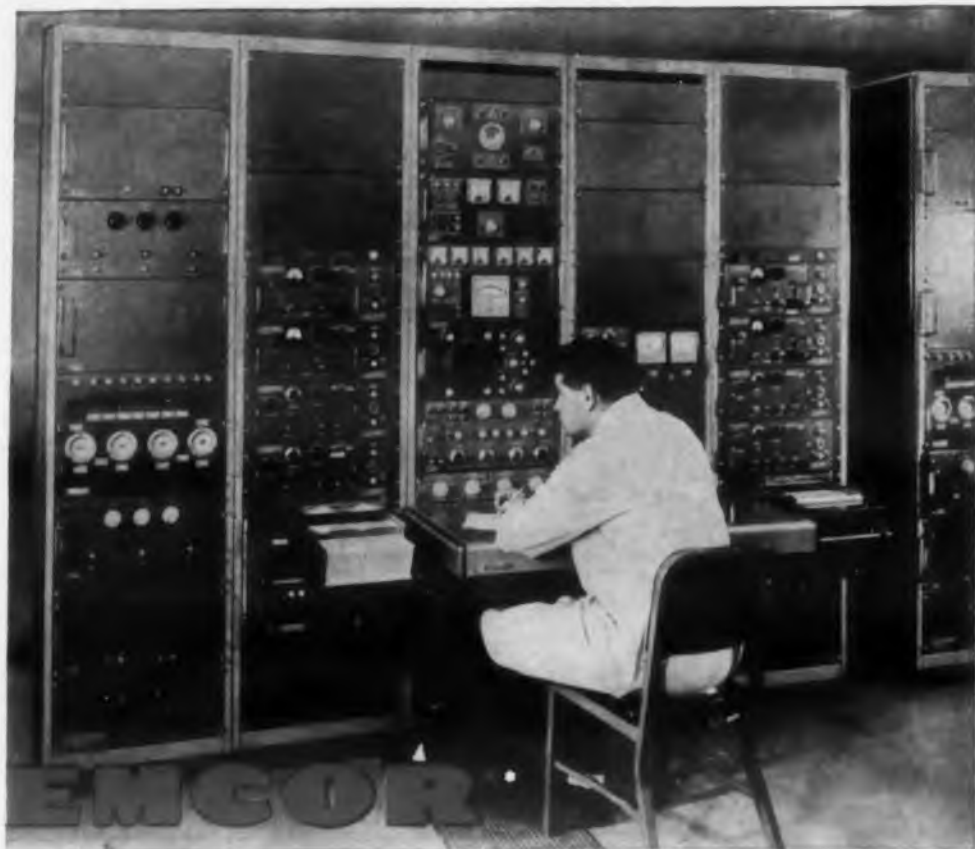
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## CABINETS HOUSE TEST EQUIPMENT FOR MEASURING DRIFT RATE IN MISSILE INERTIAL GUIDANCE GYROS



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Missile inertial guidance gyros designed and produced by American Bosch Arma Corp., Hempstead, New York, are electronically tested for "drift rate" by Sanborn "150" Oscillographic Recording Systems designed and developed by the Sanborn Company, Waltham, Massachusetts. These highly specialized test units are housed in EMCOR Cabinets. The gyros undergo torque-feedback tests as a means of measuring electronically the "gyro drift-rate" which is the error of the gyro in providing a space fixed stabilization reference. The analysis obtained from these torquing patterns enable Arma engineers to separate the "drift rate" into various contributing factors — random drift, drift due to acceleration and non-acceleration sensitive drift. The flexibility, versatility and structural capacities of over 600 basic frames in the EMCOR MODULAR ENCLOSURE SYSTEM bring dynamic engineering and "imagineering" to meet electronic and instrument packaging requirements for missile testing, firing and tracking equipment.

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## Backward Diode, GaAs Tunnel Diodes

**P**ROTOTYPE quantities of germanium backward diodes, having a low, forward voltage drop through use

of tunneling, and gallium arsenide tunnel diodes are available from the Philco Corp.

The backward diodes show a maximum peak point current of 100  $\mu$ a and a maximum forward voltage of 90 mv, at 1 ma. They have a valley capacitance of 3.5 pf, a series inductance of 1  $\mu$ h, and a series resistance of 3 ohms. The reverse breakdown voltage is 480 mv at 1 ma.

Hermetically sealed in a TO-18 package, the diodes are designed for low-level switching and small-signal applications with uhf circuitry. Possible applications include their use as a unidirectional coupling element in tunnel diode circuits and in low-voltage clamping circuits. They are priced at \$4 each in prototype quantities.

The gallium arsenide diodes have peak currents of 10 and 20 ma. The switching speed figure-of-merit (ratio of peak cur-



Curve tracer shows the static characteristic curve of the backward diode. On the horizontal scale, each large division equals 0.1 v; on the vertical, each large division equals 1 ma.

## High Efficiency at Low Voltages Claimed

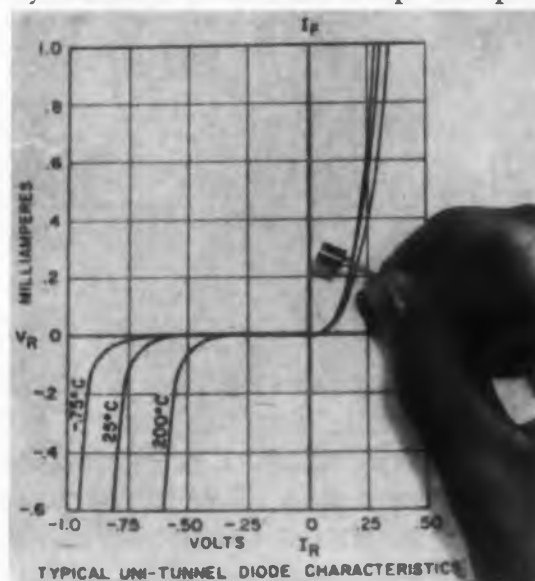
**H**IGH-EFFICIENCY performance at low-voltage levels with extreme temperature stability over a wide temperature range are claimed for the Uni-Tunnel diode, a silicon unit introduced by Hoffman Electronics Corp. Complex

circuitry previously required for low-level operations is not needed with these units, resulting in lower cost, greater reliability, and decreased space requirements.

The diode is ideal for computer logic, modulator, detector, and chopper applications, according to Z. W. Pique, a Hoffman vice president. And it is especially suited for complementing tunnel-diode circuitry, he adds.

The Uni-Tunnel diode uses the tunneling effect to provide high forward conductance at very low voltage levels. When biased in the reverse direction, the familiar tunnel diode current characteristic appears as a leakage current of microampere magnitude. Other features include extreme radiation resistance and minimum noise and drift.

The unit is designed to operate over a temperature range of  $-55$  to  $+200$  C. Twelve types of the diode are available, ranging in designations of six types each from HU-5 and HU-5A to HU-100 and



The background chart illustrates the characteristic curve for the type HU-5 Uni-Tunnel diode.

## des Made Available

rent to capacitance) is  $1 \times 10^9$   $\mu$ sec. They have an especially high switching speed when used for millimicrosecond pulse amplifiers, the firm reports. It adds:

"In high-speed switching circuits, these devices exhibit a signal swing of 1 v, compared to 0.25 v for germanium tunnel diodes, greatly simplifying circuit design. Since shift in bias only slightly affects the new units, more stable high-frequency amplifier design is also facilitated."

At 25 C,  $I_p$  for the type L-5610 is  $10 \pm 2.5\%$  ma; for the type L-5611,  $20 \pm 2.5\%$  ma.

Prototype quantities in TO-18 packages are available at \$12 each for type L-5610 and \$8 for type L-5611.

For more information on both these units—available from the firm's Lansdale Div., Church Road, Lansdale, Pa.—turn to the Reader Service Card and circle number 253.

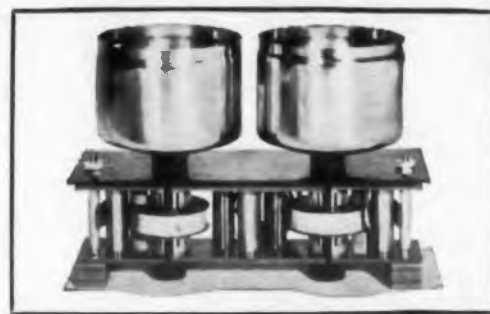
## imedior Uni-Tunnel Diode

HU-100A. Differences in the six standard types are minimum forward current, maximum reverse current and capacitance. The six A types differ from the standard units by the inclusion of guaranteed maximum capacitance values. Custom-engineered units to specific requirements are also available.

Minimum forward current at 0.25 v range from 0.5 ma for the HU-5 to 10 ma for the HU-100; maximum reverse current, for 0 to 0.5 v, range from 5 to 100  $\mu$ a.

The diodes are priced at \$10.50 in quantities of 1 to 99 and \$7.90 for 100 to 999 units for the six standard units. The six A types are priced at \$15 in quantities from 1 to 99 and \$11.25 for 100 to 999 units. All diodes are housed in the JEDEC TO-18 package.

For more information on these diodes—the firm is located at 3761 South Hill St., Los Angeles, Calif.—turn to the Reader-Service Card and circle number 252.



Electronic Grade "A" Nickel laminations produce high-frequency vibrations in these cleaning and rinsing pots of the "Watchmaster" unit, developed by American Time Products, Inc.

## High magnetostrictive effect of Nickel proves useful in new ultrasonic cleaners

NEW YORK, N. Y. — The large magnetostrictive effect of Nickel makes possible the development of ultrasonic cleaners with a great range of usefulness. In radioisotope laboratories and other atomic energy installations, for example, these cleaners remove radioactive particles from equipment. In hospitals, they clean surgical instruments.

One ultrasonic cleaner, developed by American Time Products for cleaning watches, can also be used to clean tiny component parts in electronic equipment.

ATP's chief engineer writes: "Electronic Grade "A" Nickel enables us to produce a simple, economical transducer for converting electrical energy into high-frequency vibrations. The Nickel withstands high heats, mechanical abuse and corrosive solutions, providing a long, stable life."

**Pertinent Literature:** Write for "Design of Nickel Magnetostriction Transducers."

## Thirteen 2K45 Klystron Components made of Electronic Grade "A" Nickel

Cathode	Wire (formed)
Cathode Support	Clip
Cathode Collar	Repeller
Pin	Washer
Eyelet	Flared Tube
Wire (cut)	Wire (bent)
Ribbon (cut)	

## Eight 2K25 Klystron Components made of Electronic Grade "A" Nickel

Cathode Support	Flared Tube
Foundation Collar	Strip
Shield for Electrode Beam	Repeller
Base Pin	Wire

With Nickel now plentiful, Raytheon combines several performance and production benefits in klystron design. See story at right.

## THREE NICKEL ALLOYS HELP PUSH LIFE of MAGNETRON to 6,000 HOURS

HARRISON, N. J. — Commercial airlines need reliability and long life in components for weather radar equipment. Especially in high power tubes. And they've been getting it with the type 6521 magnetron made by the Electron Tube Division of the Radio Corporation of America. Tube 6521 delivers a peak power output of 85

kilowatts and has a normal operating life of 6,000 hours.

RCA designers give much credit for the tube's long life to outstanding properties of nickel alloys:

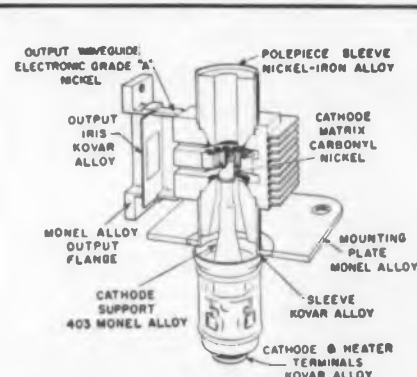
*Monel "403"\** low-permeability nickel-copper alloy, used for the cathode support, provides high strength, corrosion resistance and low magnetic permeability certified not to exceed 1.1 in a field of 0.5 oersted. Monel "403" alloy has the dimensional stability needed to maintain the cathode centered in the anode over many heating cycles. It also offers easy machining and retains its non-magnetic characteristics after cold-working and forming so that high-strength parts can be assembled without annealing.

*Monel\* nickel-copper alloy*, used for the output flange and the mounting plate, provides the strength, toughness and corrosion resistance required to help push the magnetron's life into the 6,000 hour class.

*Electronic Grade "A"\** Nickel, used for the cathode foundation, supports the electron-emitting carbonyl nickel cathode matrix. The Electronic Grade "A" Nickel provides essential strength to prevent distortion and purity to prevent contamination of the vacuum and the cathode matrix at high temperatures.

**Pertinent Literature:** Write for "Basic Data—Monel "403" Low-Permeability Nickel-Copper Alloy" and Bulletins T-5 and T-15.

\*Inco trademark



Cut-away shows where nickel alloys buttress construction of RCA magnetron.



## Forecast of Nickel availability spurs design of tubes with nickel alloy parts

WALTHAM, Mass. — Notice that the production of Nickel exceeds all anticipated demands for future years is a big reason why designers at Raytheon Manufacturing Company make many klystron parts of Electronic Grade "A" Nickel. For example, the two Raytheon tubes at left, designed for operation at 8500-9660 megacycles, have twenty-one Electronic Grade "A" Nickel parts.

Plenty of Electronic Grade "A" Nickel right from warehouse stocks in a wide range of mill forms permits

Raytheon designers to take advantage of this material's excellent vacuum and mechanical properties...and gain the benefits of simplified production and processing as well.

Electronic Grade "A" Nickel, and other nickel alloys, are supplied as wire, rod, strip, tubing, ribbon, clad-copper wire, bimetallic strip and wire, wire cloth, knitted mesh and a variety of other forms.

**HUNTINGTON ALLOY PRODUCTS DIVISION**  
The International Nickel Company, Inc.  
Huntington 17, West Virginia



**ALLOY PRODUCTS**

CIRCLE 65 ON READER-SERVICE CARD



# NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

## Diodes, Rectifiers Designed For Printed Circuits

258



The Sildisc line of silicon diodes, rectifiers, Zener diodes and double-anode diodes have a capacity of 500 mw in a case measuring 3/16 in. in diameter and 1/16 in. thick. The double-cup design features maximum heat dissipation. Mounting applications include solder-in, clip-in, plug-in, or pressfit insertion or standard attachment onto or into a printed circuit board. Other silicon, general-purpose diodes and rectifiers are rated up to 12.5 amp in ambient air; 10 to 900 piv units are available as single units or complete bridge assemblies. Zener units are rated up to 5 w, 3.9 to 200 v and have 10% tolerance.

Controls Company of America, Electron Div., Dept. ED, 845 W. Broadway Road, Temple, Ariz.  
*Availability: Immediate.*



## Microwave Transistors Give Gain Of 8 Db

254

These microwave coaxial, micro-alloy diffused base transistors have a power gain of 8 db when operating into a cavity under matched neutralized conditions at 1,000 mc. At this frequency it is possible to get over 10 mw of output. At 200 mc the units provide a gain of 22 db with a 3.8 db noise figure. The package is a hermetically sealed coaxial type with holder matched for direct insertion into a 50-ohm coaxial network.

Philco Corp., Lansdale Div., Dept. ED, Church Road, Lansdale, Pa.  
*Price: In engineering quantities, \$125 ea.*



## Transistorized Commutator Samples Millivolt, Volt Signals

257

Called the Hilo plexer, this solid state commutator simultaneously samples millivolt and volt signals. A wide range of sample speeds above 25,000 pps are available for pcm, pdm and param commutation systems. The system's major components are: a timer capable of driving 28, 43 or 88 channel input samplers at the standard rate of 900 pps; high level gates, which are single-ended input switches; low level gates, which are double-ended input switches; a low level amplifier, which is a differential unit that converts the dual output of the low level gates into a single ended pulse train.

Vector Manufacturing Co., Inc., Dept. ED, Southampton, Pa.



**Resistor Has 0.125-in. Length 0.02-in. Diam**

255

These microminiature resistors measure 0.125 in. in length and 0.02 in. in diameter. They are rated at 1/16 w with resistance values of 100 K at 1% tolerance. Resistance values up to 500 K are planned. These units can be solder pot dipped and solder tinned end can be soldered into micro-modules without changing the resistance value.

Wilrite Products, Inc., Dept. ED, Cleveland, Ohio.

*Availability: Immediately; 500-K units expected to be available shortly.*



**Delay Lines Operate In Range of -55 to +105 C**

256

Using subminiature inductors and temperature compensating capacitors, these high-density, lumped-constant delay lines operate in the temperature range of -55 to +105 C. They can be used in missiles, airborne and commercial computers and data-processing equipment. Type DL-130, shown, has a delay time of 2  $\mu$ sec, a rise time of 0.22  $\mu$ sec, an impedance of 1,000 ohms and an insertion loss of 0.001 db max. It is 3-in. long and 5-in. in diameter. Other units in this series are available with impedances ranging from 100 to 2,000 ohms, delays from 0.1 to 2  $\mu$ sec and attenuation or insertion loss as low as 0.001 db. All models are rated at 200 wvdc and 50 v dc pulse.

Allen Avionics, Dept. ED, 255 E. 2nd St., Mineola, N.Y.

*Price & Availability: \$45 ea.; from stock.*

# COMPACT TRANSISTORIZED VOLTAGE REGULATED DC POWER SUPPLIES IN WIDE VOLTAGE AND CURRENT RANGES. Proven and improved design features endow these new **KEPCO SM models\*** with excellent voltage regulation, stability and response characteristics, plus unusual compactness and longevity:

*MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SM 14-30	0-14	0-30	} 0.1%*
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	} 0.01% models available on special order
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	Meters optional on all SM models.



Model SM75-8M



Model SM325-1M



Model SM36-5M

FOR DETAILED SPECIFICATIONS ON MORE THAN 150 STANDARD MODEL POWER SUPPLIES SEND FOR KEPCO CATALOG B-601

**kepco**  
Inc.

131-36 SANFORD AVENUE • FLUSHING 52, N. Y. • IN 1-7000 • TWX # NY 4-5196

CIRCLE 66 ON READER-SERVICE CARD

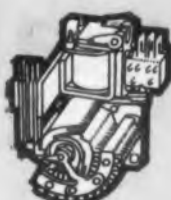


# Here's a Memory Switch You Won't Forget...

A FULL LINE OF CLARE STEPPING SWITCHES  
WITH MANY IMPROVED FEATURES



**TYPE 210**  
Has 10 points, with as many as 120 contacts in twelve 10-point levels or four 30-point levels.



**TYPE 211**  
Offers up to 132 contact points on twelve 11-point levels or four 33-point levels.



**TYPE 20**  
Up to 480 contact points in twelve 40-point levels or 320 in sixteen 20-point levels.



**TYPE 26**  
Up to 624 contact points in twelve 52-point levels or 416 in sixteen 26-point levels.



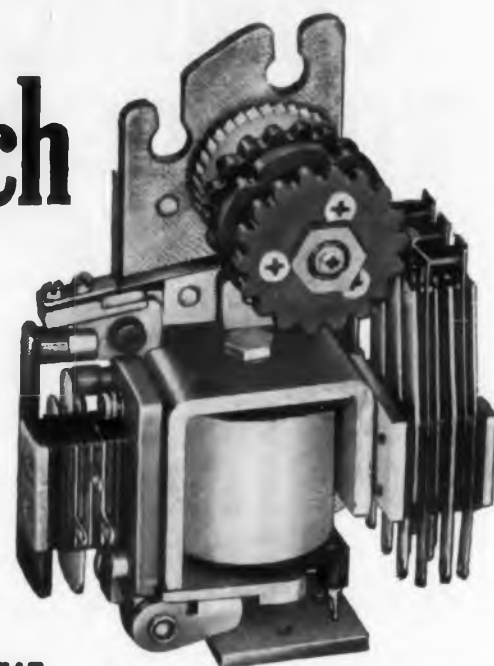
**DIRECT DRIVE**  
Up to three 10-point levels, plus an off position.



**Most complete Stepping Switch Catalog ever offered!**

Complete data on construction features, circuitry, performance characteristics and application advantages of the entire CLARE line.

**SEND FOR CATALOG 202 TODAY**



the New

**CLARE**

**CAM-OPERATED**

**type 200** offers a program control unit in reduced space and with simpler wiring. Actuating cams can be cut with a sequence of notches and lobes programmed to meet the contact switching desired. In addition, the Type 200 acts as a memory switch of unusual dependability and long life.

Operating life is measured in millions of steps. Over 30,000,000 operations have been logged with two cams and a 36-tooth ratchet; 10,000,000 with eight cams. Models are available with from 1 to 8 cams. Operating speed is 60 sps, self-interrupted, 30 sps, remote-impulsed.

The Type 200, as are all CLARE stepping switches, is available with a wide variety of hermetically sealed enclosures or dust covers to insure precise operation under all conditions.

*Production quantities available in late fall. Send for Bulletin CPC-7*

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

**CLARE**

*Relays and Related Control Components*

For Bulletin CPC-7, please circle number 183 on Reader-Service Card.  
For Catalog 202, please circle number 184 on Reader-Service Card.

## NEW PRODUCTS

### Silicon Rectifiers 533

Meet Mil specs

These diffused-junction silicon rectifiers meet the electrical, mechanical, and environmental requirements of MIL-E-1. Types 1N538, 1N540, and 1N547 have an axial-lead, top hat design. Types 1N253, 1N254, 1N255, and 1N256 are of 7/16-in. stud configuration.

Columbus Electronics Corp., Dept. ED, 1010 Saw Mill River Road, Yonkers, N.Y.

*Price & Availability: Price ranges from \$1.35 to \$4.47 ea. Delivery time is 14 days.*

### Indicator 506

Provides general information

The F Series indicators are electromagnetic units that provide general information. Operation is accomplished by a magnetic circuit that surrounds a permanent magnetic rotor. Energization of a dual coil electromagnet causes rotation of the permanent magnet rotor, thus changing the position of the dial. When the coil voltage is removed, the dial returns to the "off" position. Resistance for standard coils for 26.5 v dc operation is  $450 \pm 10\%$  ohms. Weight is 0.3 oz. It operates in a temperature range of  $-55$  to  $+125$  C and stands a vibration of 10 g to 1,000 cycles and a shock of 50 g for  $10 \pm 1$  msec.

E. V. Naybor Laboratories, Inc., Dept. ED, Port Washington, N. Y.

### Tubular Relay 562

Armature is only moving part

The armature of the Series 120 tubular relay is the only moving part. Hermetically sealed and dry-nitrogen filled, the unit stands a vibration of 15 g from 10 to 2,000 cps and a shock of 30 g when de-energized, 100 g when energized. Its life is rated at more than 200 million mechanical operations.

Wheelock Signals, Inc., Dept. ED, Long Branch, N.J.

# Transitron

introduces

an exciting new device for simpler, more reliable, more economical switching circuitry

# BINISTOR

(BY-NIS-TOR)

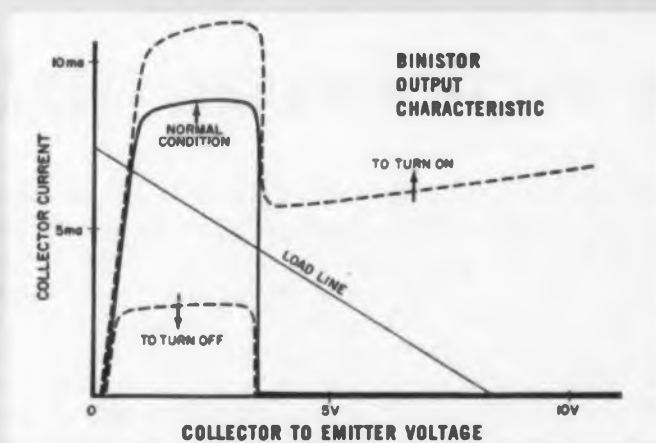
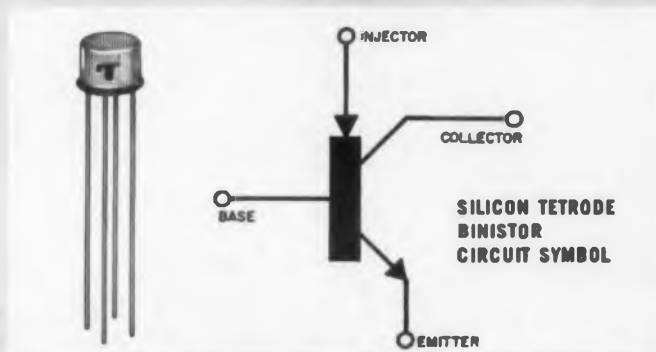
The Silicon NPN Tetrode binistor is a new component and a new concept for the circuit designer!

The key parameters of this bi-stable, negative resistance device are determined by external circuitry in contrast to existing devices. The significant reduction of peripheral circuitry results in outstanding savings in cost, space, weight and solder connections. For example, a typical flip-flop requires at least 13 components versus only 4 in an equivalent binistor stage. Very large current and voltage gains are realized in both on and off directions. Inputs and output are compatible in level with typical transistor and diode circuits. The tetrode binistor can operate from  $-80^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ .

To learn more of this important new development — THE BINISTOR — and how it works — write for Bulletin No. TE-1360.

#### CONDENSED SPECIFICATIONS TRANSITRON BINISTOR

Typical Turn-off Current Gain	50 @ 15ma Collector Current
Operating Collector Current Range	50 $\mu\text{a}$ to 15ma
$I_b$ critical	0.5ma @ 5ma Collector Current
Operating Temperature Range with-out Temperature Compensation	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$



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wakefield, melrose, boston, mass.

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TUxedo 9-4242
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MO 1415
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UTah 1-6060
- OHIO**, Dayton 2  
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BAldwin 4-1111
- OKLAHOMA**, Tulsa  
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2403 Farrington St.  
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## Design engineer with a problem:

# "Small size is not enough!"

"Nothing fits . . . components too bulky . . . have to save space . . . have to trim size . . . maybe eliminate tubes . . . maybe brackets, too . . . maybe smaller relays. Yes, relays . . . if there's a smaller one that's fast enough, strong enough, tough enough. Better be careful though . . . can't sacrifice performance . . . or reliability. Now, where are those sealed relay catalogs?"

We at General Electric appreciate this respect for relay performance. Relay tasks are normally too critical to risk compromising reliability no matter what the gain—small size not excepted.

That's why performance always comes first in General Electric sealed relays.

But we haven't forgotten the importance of miniaturization either. In fact, General Electric designers have pioneered in miniaturized relays four times in the past ten years—Miniature (1951), Micro-miniature (1955), and 4-pole and Unimite (1959). Each relay represents an advance in performance, as well as a reduction in size.

Superior performance is no accident with General Electric sealed relays. It is the product of General Electric's advanced technology, ever improving

manufacturing processes, relentless testing, and stringent quality control.

For relays that offer top performance and reliability in the smallest available packages, turn first to your G-E Sealed Relay Catalog. As always, more information is available from your nearby General Electric Sales Engineer. General Electric Co., Specialty Control Dept., Waynesboro, Virginia.

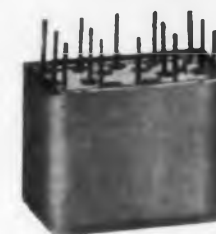
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**GENERAL ELECTRIC SEALED RELAYS—UNMATCHED FOR RELIABILITY**

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## General Electric sealed relays for the '60's



### 4-POLE MICRO- MINIATURE

New grid-space, 4-pole double-throw micro-miniature relay features all-welded construction to eliminate flux contaminants. Knife-edge armature bearing and other design features provide structure capable of mechanical life in excess of 10 million operations. Rated 2 amps at 28 volts DC, or 115 volts AC resistive; requires only 100 milliwatts per pole. Other specifications are:

**Operating sensitivity:** 400 milliwatts at pickup voltages; continuous duty.

**Vibration:** 55 to 2000 cps at 30G's with 0.195" max. excursion 10 to 55 cps.

**Shock:** 50G's for 11 ms operating.

**Temperature range:** 125 C to -65 C.

**Operating time:** 6 milliseconds max. including bounce.

**Insulation resistance:** 1000 megohms min.

**Dielectric strength:** 1000 volts rms except 600 volts across contact gap.

**Contact resistance:** 0.050 ohms maximum (0.1 ohms max. after life).

**Release time:** 5 milliseconds maximum including bounce.



**MINIATURE:** Long-life type; rated 5 amps at 28 volts DC; in 2- or 4-pole double-throw and 6PNO forms. Ideal for ground jobs.



**MICRO-MINIATURE:** Crystal can type, all popular coils and mounting forms; 2 amps, 28 v DC or 115 v AC. Grid-spaced terminals available.



**UNIMITE:** World's smallest 1-amp sealed relay! Operates in 1.5 millisecond, releases in 3.5 milliseconds. Isolated contact chamber; all-welded construction.

General Electric Company  
Section A792-18  
Schenectady, New York

Please send me a free copy of the 1959-60 Sealed Relay Catalog.

Name

Address

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**GENERAL  ELECTRIC**

CIRCLE 71 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## NEW PRODUCTS

### Fixed Coaxial Attenuators

369

For broad band application



These attenuators are bi-directional units constructed in pi-type circuits and feature broad band application, low vswr and compact size. They cover a frequency range from dc to 2,000 mc and are available with any value of attenuation from 1 to 40 db. Vswr is 1.15 max to 1,000 mc and 1.35 max to 2,000 mc, power handling is 1 w/cw and impedance is 50 ohms. They are furnished with either type N, C, BNC or TNC connectors.

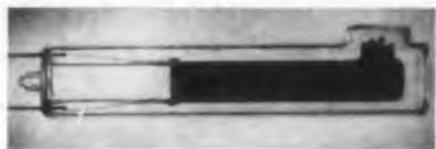
Maury and Associates, Dept. ED, 10373 Mills Ave., Montclair, Calif.

**Price & Availability:** Price range is from \$50 to \$55; available in moderate quantities from stock to 3 weeks.

### Cooled-Cell PbS Detectors

368

Mounted in Dewar configurations



These Dewar-mounted IR detectors are designed for operation at room temperature and cooled to  $-196^{\circ}\text{C}$ , with spectral response out to 4.5 microns. The detector sensitive area can be varied in size from 0.010 to 0.200 in., according to customer specifications. At standard conditions the electrical characteristics are: detectivity, less than  $1.7 \times 10^8$  in. cm per w at  $-78^{\circ}\text{C}$ ; dark resistance,  $-0.5$  to 5.0 meg per square; time constant, 800 to 2,000  $\mu\text{sec}$ .

Infrared Industries, Inc., Dept. ED, P.O. Box 42, Waltham, Mass.

**Availability:** From stock; price available upon request.

### Wiring Duct Fittings

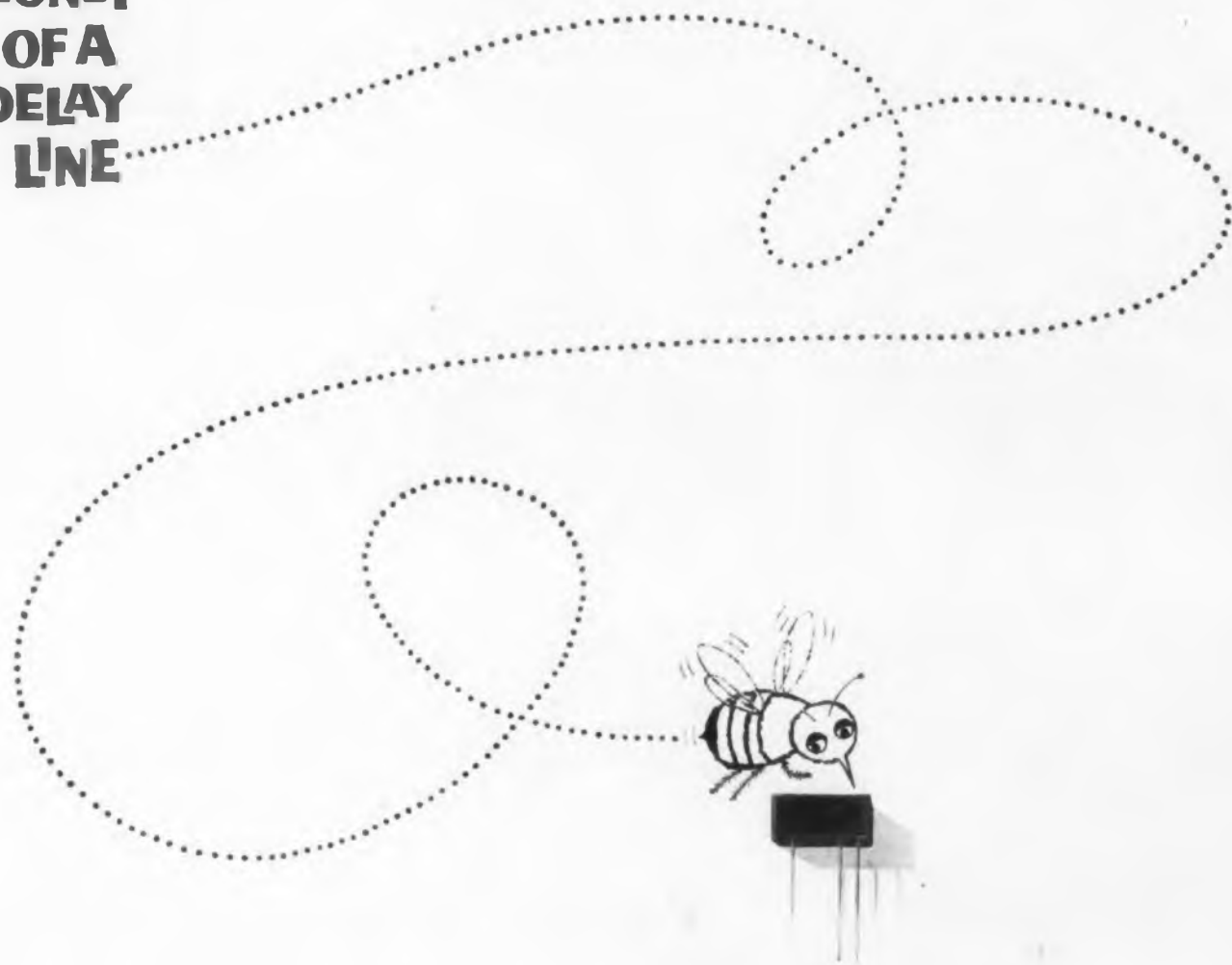
519

Corner and "T" junctions and couplings

Molded one-piece corner junctions, "T" junctions and straight-through couplings are available for use with the firm's plastic wiring duct. The sections snap into place without special fitting operations. The fittings are available in 13 different sizes, plus four basic sizes to be field-cut to match duct height.

Panduit Corp., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

## A HONEY OF A DELAY LINE



## ESC'S NEW SUBMINIATURE LUMPED CONSTANT DELAY LINE\*

Model 16-92 is the latest example of creative versatility from ESC, America's largest producer of custom-built and stock delay lines. The specifications: 1/10 usec. delay, 1,600 ohm impedance,  $\frac{1}{4}$ " x  $\frac{1}{4}$ " x  $\frac{1}{2}$ " dimensions. Only ESC produces so many different delay lines, for so many varied applications. From the largest to the smallest, ESC has the best, most economical answer to your particular delay line problem. Write today for complete technical data.

\*shown actual size



# ESC

**ELECTRONICS CORP.** 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

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CIRCLE 72 ON READER-SERVICE CARD





## ENGINEERING REPORT ON BENDIX COMPONENTS



## VERSATILITY PLUS—IN GROUND ANTENNA PEDESTALS

This Bendix Ground Antenna Pedestal is unique in that it can be easily modified to a variety of radar antenna applications, some of which are shown above. In addition, the pedestal is *air transportable*—weighing only 700 lbs.;

*accurate*—better than 0.5 mils; *available*—already designed, tooled and available for your immediate prototype needs—the product of our extensive field and test experience in building for highly accurate tracking of aircraft and missiles.

### ADDITIONAL CHARACTERISTICS:

Optional control indicators for various servo drives.

1/2 to 2 horsepower motors standard. Other power and speeds optional.

For further information about this unit—and others in the Eclipse-Pioneer "family" of radar antenna devices—write:

**Eclipse-Pioneer Division**

Teterboro, N. J.



District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.  
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

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CIRCLE 73 ON READER-SERVICE CARD

## NEW PRODUCTS

### Resistor Standards

370

To measure ultra high resistance



Three groups of resistor standards are offered to measure ultra high resistances. Reference resistors, measured and certified to within 1% are offered in six values between 100 and 10 million meg. The precision series are selected to within 10% and the exact series to within 1% of listed values; both series are measured and certified within 0.2% and are available in five values between 10 and 100,000 meg.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

*Price & Availability: From \$34 to \$198 ea; delivery is: reference resistors, 30 days; precision series, 60 days; exact series, 90 days.*

### Transistorized Decade Counter 371

Has single operating voltage



This 1-mc, transistorized, decade counter, Model 1302, with 10-number display, features a single operating voltage of +100 v, 50 ma. Input requirements are: -10 v. It plugs into a standard, 10-pin printed circuit counter. Weight is 4 oz; size 3-1/2 x 1 x 4-1/8 in.

Robotomics, Inc., Dept. ED, 4624 E. Garfield, Phoenix, Ariz.

*Price & Availability: In quantities of 100 and up, \$74 ea; available in 3 to 5 weeks after order received in quantities of 1 to 24.*

### DC Power Supply

528

Instantly switches from ac to battery

This dc power supply, normally operating from 115 v ac, will instantaneously switch to battery operation in event of a power failure. Output is short-circuit proof and adjustable from 130 to 160 v dc at 100 ma, with a stabilized heater output from 5.5 to 7 v, 3 amp dc. Ripple is 1.5 mv and regulation 0.2%.

R S Electronics Corp., Dept. ED, P.O. Box 11368, Station A, Palo Alto, Calif.

## ENGINEERING REPORT ON OTHER BENDIX COMPONENT PACKAGES



### CONTROL AMPLIFIER

Electronic unit, size of cigarette pack, amplifies small error signals.



This is a compact, modular electronic control amplifier that boosts small error signals to power electro-mechanical components, providing a gain factor of 500. Hermetically sealed in nitrogen and hydrogen. Latest design techniques result in direct 115-volt, 400-cps excitation with lower power consumption than on conventional bridge-type amplifiers. Meets a wide range of applications due to low power consumption, high gain, load capacity, and compactness. Ask for full details.

### LOW-PASS FILTER-AMPLIFIER

Advanced circuitry provides extended operating range.



The amplifier is a keyed, plug-in, modular card assembly incorporating latest in transistor and silicon diode circuitry. It amplifies low-level 400-cps modulated signals and produces a 400-cps modulated output signal having a time lag of approximately 0.1, 3.5, 10, or 15 seconds, depending on external connections. Where memory functions are not required, eliminates need for electro-mechanical assemblies by providing either synchronization or data smoothing in the amplifier-computer. Compact design and extended operating characteristics make for flexibility of application. Write for details.

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RADAR DEVICES • INSTRUMENTATION  
PACKAGED COMPONENTS

Eclipse-Pioneer Division



Teterboro, N. J.

CIRCLE 74 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Silicon Mesa Transistor

508

### General purpose, small signal uses

This general purpose, npn, silicon mesa transistor is designed for small signal applications up to 200 mc. Designated type 2N752, it has a high gain at up to 200 mc and at collector-emitter currents up to 10 ma. It dissipates 300 mw in free air; a minimum collector-to-emitter voltage of 45 v and an emitter-to-base voltage of 8 v are guaranteed. Leakage current is 5  $\mu$ a at 150 C, and collector-base capacitance is 5 pf.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

## Silver-Zinc Battery 552

### For missile and space vehicle use

Model P80A silver-zinc battery is for use in missile and space vehicle auxiliary power units. Automatically activated by a solid-propellant gas mechanism, the unit provides 200 amp at 28 v. Maximum current is 400 amp and discharge time is 1.8 min. The battery has 20 cells. Activation signal is 4 amp at 28 v and activation time is 0.8 sec. The unit stands acceleration of 50 g, shock to 50 g, and vibration to 30 g. Ambient temperature range is 60 to 100 F.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Availability: Made on order.

## AC Power Supply 375

### Provides 130 v

Used with model 250AR power amplifier, model 250-XI power supply delivers 130 v ac over the frequency range of 30 cps to 10 kc. The supply is equipped with a voltmeter which indicates the output between 80 to 150 v  $\pm$ 1%. The unit is suitable for powering small instruments, up to 40 w; for meter calibration; and for matching 500- or 600-ohm loads.

H. H. Scott, Inc., Dept. ED, 111 Powdermill Road, Maynard, Mass.

# When precise temperature control is mandatory STEMCO TYPE MX THERMOSTATS are a must

In missiles, avionics, astronics, or any electronic application requiring the closest temperature control, check into Stemco Type MX Thermostats first. They're compact for minimum cubage . . . light in weight . . . withstand high G loads . . . are absolutely reliable under wide ambient temperature swings.

Basic design flexibility of Stemco Type MX Thermostats means they can be supplied from regular production runs in a wide variety of models. Semi-enclosed types with metal bases; hermetically sealed types in round enclosures or crystal cans. Wide selection of terminal arrangements, mounting provisions, brackets, etc., available. Units individually packaged in polyethylene with inspectors' readings of disc opening and closing temperatures.

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A-1041A

2° to 6°F differentials available  
1° to 4°F differentials on special order



**TYPE MX HERMETICALLY SEALED**—Electrically independent bimetal disc. Rated 3 amperes. basis 250,000 operations



**TYPE MX SEMI-ENCLOSED**—Electrically identical to Type MX Hermetically Sealed. Both Types available with one terminal grounded or both terminals insulated.



STEVENS manufacturing company, inc.  
P. O. Box 1007, Mansfield, Ohio

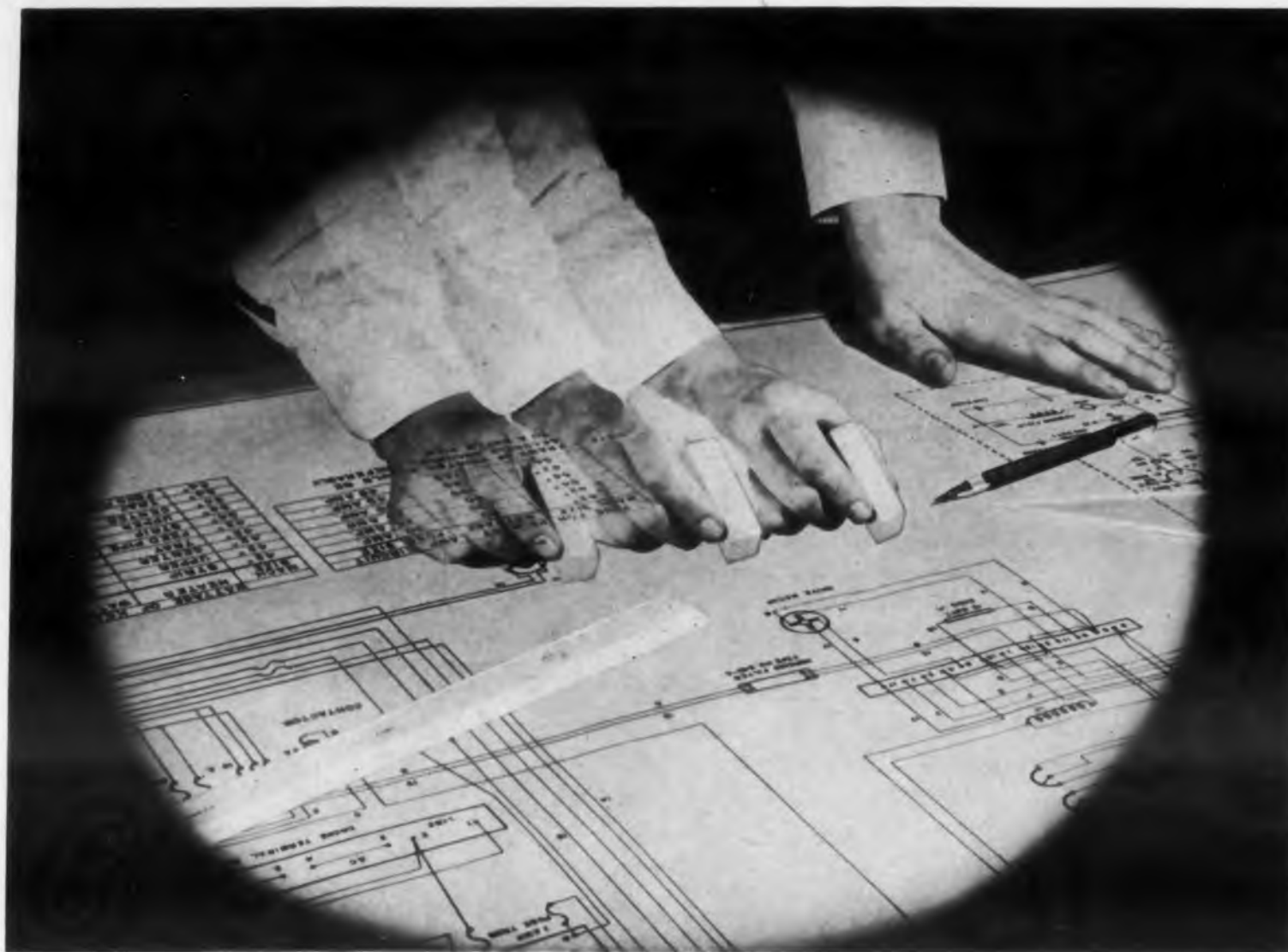
STEMCO

THERMOSTATS

CIRCLE 75 ON READER-SERVICE CARD

CE CARD  
7, 1960





Make this erasure test and see for yourself why . . .

## CRONAFLEX<sup>®</sup> HAS THE BEST DRAFTING SURFACE YOU CAN USE!

A good example of the consistent, balanced surface of CRONAFLEX is its superior *erasability*. CRONAFLEX not only erases easily and cleanly; it takes repeated erasing without ghosting or surface damage.

To prove it, make this simple test: draw a series of 6 lines horizontally on CRONAFLEX. Erase a vertical path through

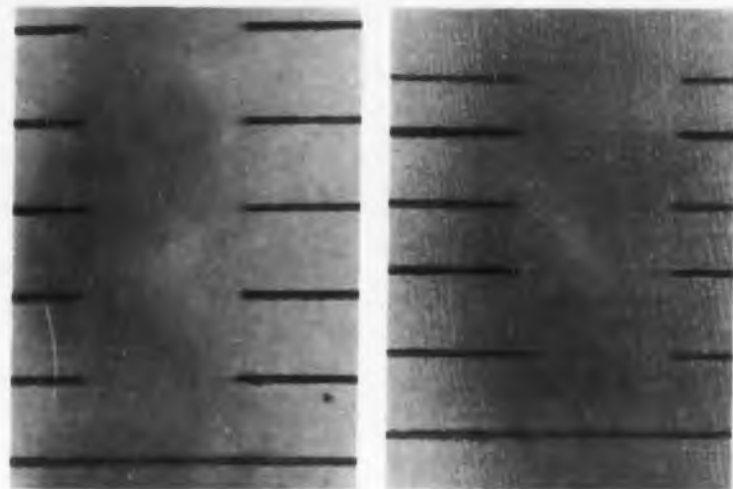
each line as you draw it, with a stroke long enough so that each succeeding line is drawn through another erasure. Now make the same test on the best grade of pencil cloth you have and compare the results. For more proof, reproduce each sample in a diazo machine and compare the prints.

Superior covering power, cleanness of erasures and consistent line density—despite repeated erasing—are just a few of the reasons why CRONAFLEX gives you the best drafting surface you can use. For others, contact your local Du Pont Technical Representative or call your local Du Pont Photo Products Sales Office listed below. E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, Toronto.



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CIRCLE 76 ON READER-SERVICE CARD

## NEW PRODUCTS

### Sequence Switch

374

Multi-position, multi-channel



This electronic sequence switch provides for three-position switching of nine signal channels. The unit is switched by a 28-v dc input pulse of 0.050 sec minimum duration. The unit is hermetically sealed and designed for a minimum life of 50,000 cycles at 10 cpm. It is capable of withstanding an inverse voltage of 31 v dc with no damage.

Tempo Instrument Inc., Dept. ED, P.O. Box 338, Hicksville, N.Y.

*Price & Availability: Delivery is 21 to 35 days after order received; price is dependent on design requirements.*

### Tunnel Diode

706

Oscillates above 4,000 mc

This tunnel diode can oscillate at frequencies above 4,000 mc. In addition to a frequency range of 3 kmc, the diodes have a peak-to-valley ratio of 5 to 1, a peak current up to 4 ma, at approximately 50 mv, and a minimum current at about 350 mv. They are enclosed in a ceramic package designed for microwave stripline and cavity applications. The package's inductance is 0.2 mμh.

Sylvania Electric Products Inc., Semiconductor Div., Dept. ED, Woburn, Mass.

*Availability: Sample quantities available.*

### Switching Transistor

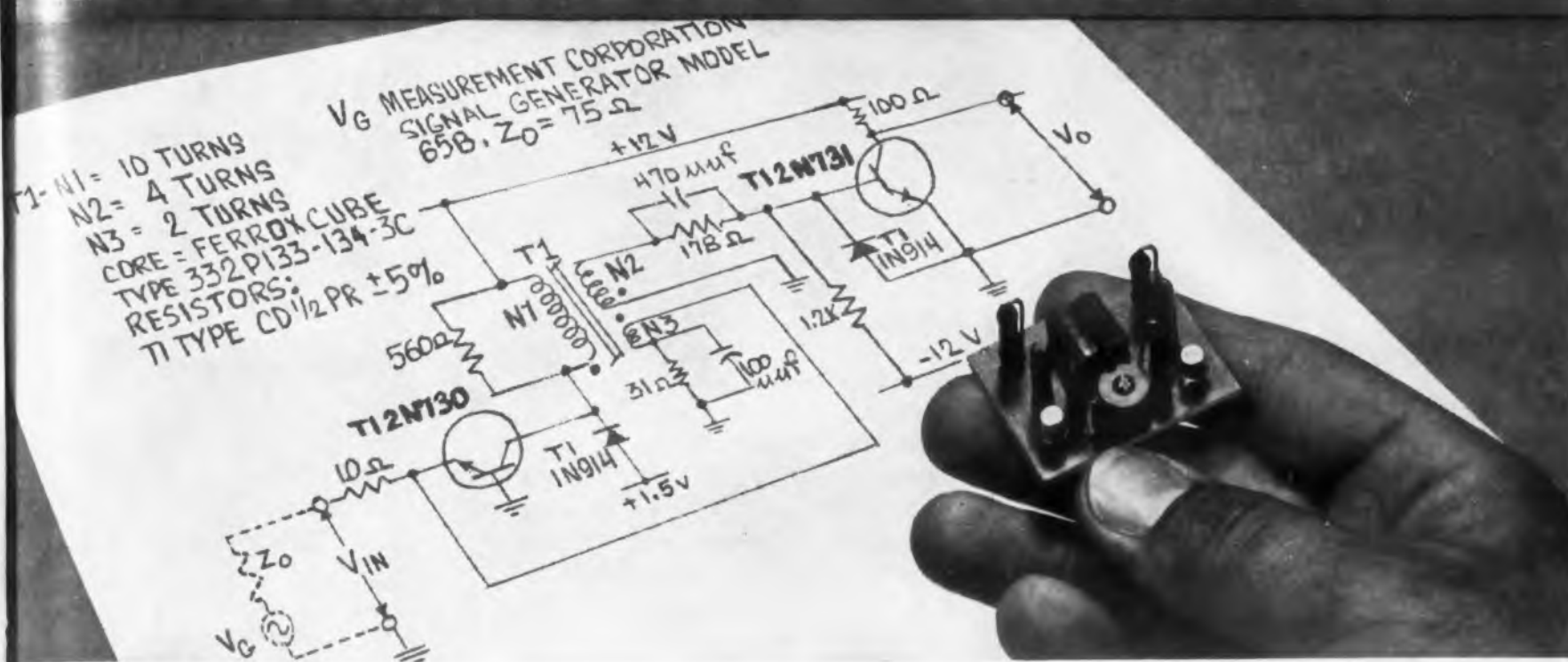
704

Collector current rating is 500 ma

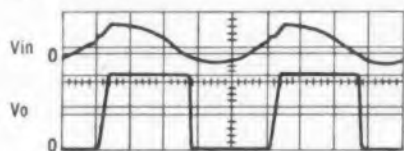
Type 2N1384 germanium, drift-field transistor has a collector current rating of 500 ma and a dissipation rating of 240 mw max at 25 C. Maximum dc transfer ratio is 20 when  $I_c$  is  $-200$  ma. Maximum stored-base charge for  $I_c$  at  $-10$  ma and  $I_b$  at  $-1$  ma is 800 micromicrocoulombs. The unit is suitable for use in saturated memory-core drivers, pulse amplifiers, inverters, flip-flops, and logic gate circuits.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

# HOW TO GENERATE 100-ma PULSES AT 10 mc



## ... WITH TI 2N730 and 2N731 SILICON MESA TRANSISTORS

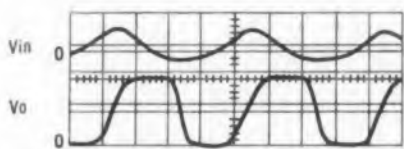


**1 Megacycle**  
VERT.—5v/cm  
HORIZ.—2 μsec/cm  
T<sub>A</sub>—25°C

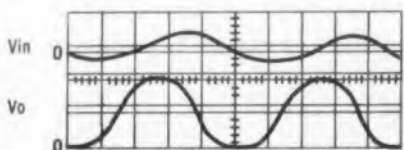


See how these performance-proved characteristics apply to your high-current, high-speed switching circuits...

**High-current loads**— Switch 100 ma at 10-mc rates using TI 2N730 and 2N731 transistors (see applications circuit) • **Fast switching**— Note 20 millimicrosecond rise and fall times on the waveforms illustrated • **Size and weight**— Save both size and weight with the subminiature TO-18 packaging of the TI 2N730 and 2N731 'mesas' • **Dissipation**— Get a full 500 mw (T<sub>A</sub> = 25°C) or 1.5w (T<sub>C</sub> = 25°C) with beta spreads of 20-60 (2N730) and 40-120 (2N731) • **Reliability**— TI Quality Assurance guarantees you performance to specifications • **Applications**— Use the TI 2N730 and 2N731 guaranteed performance in your digital computer clock pulse generators and similar high-load, high-speed, high-reliability circuits. Check these specifications:



**5 Megacycles**  
VERT.—5v/cm  
HORIZ.—50 μsec/cm  
T<sub>A</sub>—25°C



**10 Megacycles**  
VERT.—5v/cm  
HORIZ.—20 μsec/cm  
T<sub>A</sub>—25°C

electrical characteristics at 25°C ambient (unless otherwise noted)			2N730		2N731		unit	
PARAMETER	TEST CONDITIONS		min	max	min	max		
I <sub>CBO</sub>	Collector Reverse Current	V <sub>CB</sub> = 30v I <sub>E</sub> = 0	—	1.0	—	1.0	μa	Collector-Base Voltage . . . . .
I <sub>CBO</sub>	Collector Reverse Current at 150°C	V <sub>CB</sub> = 30v I <sub>E</sub> = 0	—	100	—	100	μa	Collector-Emitter Voltage . . . . .
BV <sub>CB0</sub>	Collector-Base Breakdown Voltage	I <sub>C</sub> = 100μa I <sub>E</sub> = 0	60	—	60	—	v	Emitter-Base Voltage . . . . .
BV <sub>CER</sub>	Collector-Emitter Breakdown Voltage	I <sub>CER</sub> = 100ma R <sub>BE</sub> = 10 ohms	40	—	40	—	v	Total Device Dissipation . . . . .
BV <sub>EBO</sub>	Emitter-Base Breakdown Voltage	I <sub>E</sub> = 100 μa I <sub>C</sub> = 0	5	—	5	—	v	Total Device Dissipation at Case Temperature 25°C . . . . .
h <sub>FE</sub>	DC Forward Current Transfer Ratio	I <sub>C</sub> = 150ma V <sub>CE</sub> = 10v	20	60	40	120		Storage Temperature Range . . . . .
V <sub>BE(sat)</sub>	Base-Emitter Voltage	I <sub>C</sub> = 150ma I <sub>B</sub> = 15ma	—	1.3	—	1.3	v	
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	I <sub>C</sub> = 150ma I <sub>B</sub> = 15ma	—	1.5	—	1.5	v	
h <sub>fe</sub>	AC Common Emitter Forward Current Transfer Ratio	I <sub>C</sub> = 50ma V <sub>CE</sub> = 10v f = 20mc	2.0	—	2.5	—		
C <sub>ob</sub>	Common-Base Output Capacitance	I <sub>E</sub> = 0 V <sub>CB</sub> = 10v f = 1mc	—	35	—	35	μf	

\*Pulse conditions: Length = 300μs, duty cycle < 2%

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GENERAL CHARACTERISTICS ... MODEL 30	
*Drive: 6.3 volts, 60 CPS	Phase: $25^\circ \pm 10^\circ$
Dwell: Average, $175^\circ$	Balance: Within $15^\circ$
Contact Rating: 2 ma, 10 v.	Contact Action: SPDT BBM

\*Nominal. Non-resonant armature construction permits wide drive frequency span.

WESCON BOOTHS 711 - 712



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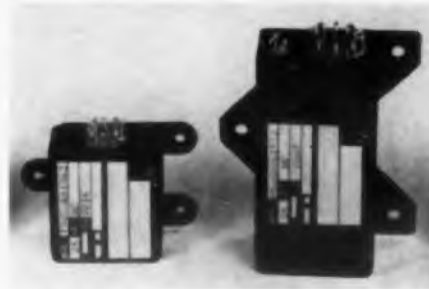
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## NEW PRODUCTS

### Time Delay Relays

372

Have precise time delay-on-drop-out



These electronic time delay relays provide a precise time delay-on-drop-out that may be factory-set between 0.02 and 300 sec. They have accuracy ratings of  $\pm 10\%$ ,  $\pm 5\%$  or  $\pm 3\%$  of nominal time delay. These ratings are guaranteed under operating and environmental conditions including: input voltage variations from 18 to 31 v dc; temperatures from  $-55$  to  $+125$  C; vibration and acceleration to 20 g; shock to 50 g, 11 msec.

Tempo Instrument Inc., Dept. ED, P.O. Box 338, Hicksville, N.Y.

*Price & Availability: 21 to 35 days after order received; price dependent on design requirements*

### AC Power Supply

677

Output is 100 va per phase

Model T246 ac power supply has a power output of 100 va per phase. Range and frequency accuracy is  $\pm 0.075\%$  from 375 to 423 cps and  $\pm 0.4\%$  from 290 to 520 cps. Distortion is less than 1%. The unit can be used as a power source for bench testing alternator control panels, servomotors, gyros, and ac measuring equipment.

Avtron Manufacturing, Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

### Gas Density Switch

707

Operates in temperatures to 400 F

Model RM-76 gas density switch can operate in temperatures up to 400 F. Among its applications are: aircraft and missile equipment, power transformers and packaged electronic equipment. It has actuating pressure ranges of 0.0026 to 0.006 lb mols per cu ft. Operating between  $-45$  and 400 F, it has an accuracy of  $\pm 0.5$  psi from  $-85$  to  $+185$  and  $\pm 1.5$  psi from 185 to 400 F. Weighing less than 1.8 oz, the switch measures 1-27/32 in. in length and 7/8 in. in diameter. They are available as spst or spdt units and are rated at 28 v dc, 110 v ac and 5 amp resistive load.

Newark Controls Co., Dept. ED, Bloomfield, N.J.

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CIRCLE 80 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Time Delay Relays 504

Delays up to 15 sec

Series TLC time delay relays have a magnetic and electronic circuit working in conjunction to provide delays up to 15 sec and greater. Operate and full re-cycle time is accomplished in less than 25 msec. Contact arrangements are spdt and double break at 10 amp; also spdt, dpdt, and tpdt at 5 amp. Accuracy is  $\pm 10\%$  under all environmental conditions,  $\pm 5\%$  on special order. The coil operates on either 26.5 v dc and 115 v ac, 50 to 400 cps. The unit operates at up to 50 g of shock and 10 g of vibration up to 1,000 cycles. It weighs 8.25 oz.

E. V. Naybor Laboratories, Inc., Dept. ED, Port Washington, N. Y.  
**Price & Availability:** Prices between \$56 and \$64 each in quantities of 1 to 9; delivery is 30 to 60 days after order received.

## Blower 671

For installation under cabinet

The Pontoon base blower, designed for installation under a standard modular electronic cabinet, will support a 2,000-lb load. Two basic units are offered, one with a 500-cfm output and one with a 250-cfm output. Centrifugal blowers are used.

McLean Engineering Laboratories, Dept. ED, P. O. Box 228, Princeton, N.J.

## Reference Transformer 376

Operates to temperatures of 200 F

Designed to be incorporated into a circuit using linear-variable differential transformers, model MRT-1 micrometer reference transformer can be used as a zero-adjust or zero-suppression device, and for control point setting, or for null-balancing. Capable of operating at temperatures to 200 F, the unit has a resolution of 0.00025 in.

Schaevitz Engineering, Dept. ED Route 130 at Schaevitz Blvd., Pennsauken, N.J.

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*the first truly*  
**VERTICAL**  
*slide*  
**attenuator**

**6" high**  
**2" deep\***  
**1½" wide**



Daven's Series 825 and 835 are the first truly vertical slide attenuators — with finger-fitting knob that moves in a straight line with feather-light pressure. The measurements: just 6" vertical, 2" deep,\* 1½" wide! The wiper arm rides on solid silver alloy contacts, not on the resistance element, providing noise-free operation and extremely long life.

Used in TV master controls, recording studios, motion picture sound consoles, turntable volume controls, speech input consoles, high fidelity units,

and many other applications, Daven vertical slide attenuators offer the following features:

- Available as balanced and unbalanced ladders, T-networks, single and dual potentiometers
- In 20 and 30 db steps
- With or without "Cue" position
- Complete protection against dirt and foreign objects
- Connector-type terminals on rear
- Available singly or with 2, 3, 4 or more units side by side

\*Exclusive of connector

For further information, write:

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The results of these polls have been most helpful to potential advertisers, offering proof of the important communication function provided by this magazine.

Those subscribers who have cooperated in filling out their inquiry questionnaire deserve our thanks. By helping us to prepare more accurate information about the market we serve, *Electronic Design* becomes an even more basic media choice in this industry.

**ELECTRONIC  
DESIGN**

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830 THIRD AVENUE, NEW YORK 22, N.Y. PLaza 1-5530

## NEW PRODUCTS

### Miniature Accelerometer

373

Sensitivity is 30 peak mv per peak g



The Model 502 accelerometer is a stainless steel, 1/2-in. hexagon, 0.45 in. high, it weighs 9 g and has sensitivity of 30 peak mv per peak g. Frequency response is 2 cps to 6 kc with the resonant frequency at 100 kc maximum acceleration is 10,000 g; temperature rating is -65 to +500 F for high temperature units.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. and Bullens Lane, Woodlyne, Pa.

**Price & Availability:** One to five quantities is \$155 ea; six to ten, \$139.50; 11 to 50, \$131. Delivery is two weeks after order is received.

### Radiation Sources

578

Simulates radiation from distant targets



Models 11-1100 and 11-1101 collimated-infrared radiation sources provide 4-in. diameter beams to simulate radiation from distant targets. The one unit is for laboratory use and the other is for airborne applications. They comprise precision temperature controllers and black body simulators. The simulator is nitrogen-pressurized and is sealed to prevent entrance of moisture and dust and to permit operation at high altitudes.

Barnes Engineering Co., Dept. ED, 30 Commerce Rd., Stamford, Conn.

### Silicon Computer Diodes

568

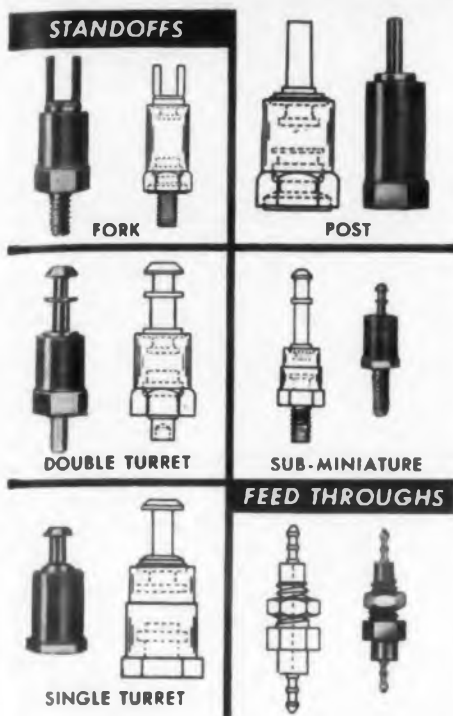
PIV rated at 40 v

Types MA-4231, MA-4238, and MA-4230 have a rated piv of 40 v at 25 C and 0.1  $\mu$ a and at 100 C and 10  $\mu$ a. Maximum capacitance at -6 v is 0.8, 2, and 2 pf for the respective diodes. Forward

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Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

**Plating Combinations:** Many terminal and mounting combinations furnished as standard.

**Specials:** Body materials and plating combinations, also dimensions, can be supplied to specifications.

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Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.



**WHITSO, INC.**  
9316 Byron Street, Schiller Park, Illinois  
(Chicago Suburb)

CIRCLE 82 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

voltage drop at 25 C and 10 ma is, respectively, 1.5 v, 1 v (at 20 ma), and 1 v. The recovery time to 1 ma when switched from 10 ma to -5 v through a 100-ohm loop impedance, is 0.004  $\mu$ sec max at 25 C.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

**Availability:** Available in production quantities.

### Power Converter

377

Supplies 28 v dc at 2 amp



The Model 3078 static, power converter supplies 28 v dc  $\pm 5\%$  at 0.6 to 2 amp from a 115 v 60 cps input. The device employs silicon diodes and is regulated by a magnetic amplifier. It is hermetically sealed, measures 4-3/4 x 5 x 8 in., and weighs 14 lb. The unit is designed for continuous operation in ground checkout systems and field installations.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

### DC Power Supplies

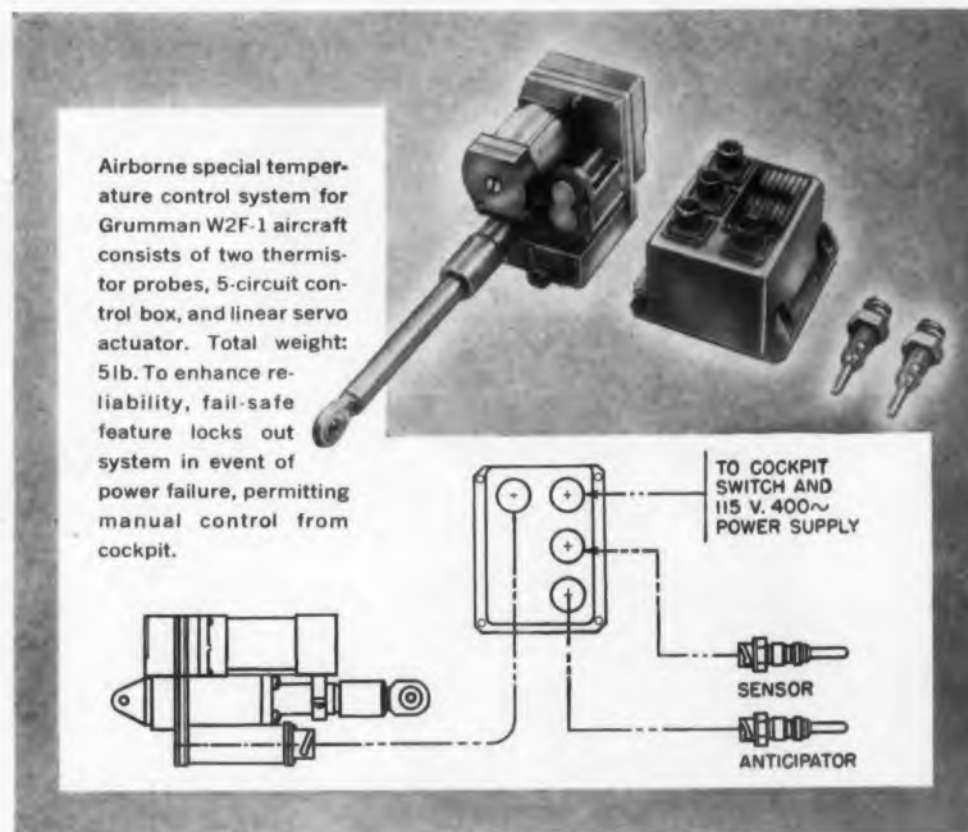
580

Outputs are 6.3 to 36 v



Ranging in output from 6.3 to 36 v, the QD series dc power supplies are completely contained in military-type cans. They have a maximum output rating of 30 w with a voltage regulation of  $\pm 0.05\%$  against line and load variations. They are insensitive to input frequency variations and operate on 50, 60, or 400 cps. Ripple is less than 1 mv rms.

Raytheon Co., Sorensen & Co., Dept. ED, Richards Ave., S. Norwalk, Conn.



## Airborne special control system holds engine oil temperature to $\pm 3^\circ$ F

The Grumman W2F-1 airborne-early-warning aircraft, because it is operational over a wide range of environments and altitudes, imposes a severe problem in control of engine lube oil temperature. For efficient engine operation, oil temperature must be maintained within  $\pm 3^\circ$  F at the air/oil heat exchanger. This, in spite of the considerable (10-100 sec.) time lag in the exchanger and in spite of the non-linear characteristics of the heat exchanger with ram air valve position.

To solve these problems, Airborne developed an electromechanical system utilizing two thermistor probes. An "anticipator" probe at the exchanger inlet senses temperature variations in oil coming

from the engine, initiating a command to the actuator to correct the ram air valve setting. A "sensor" probe at the exchanger outlet monitors steady state temperature, comparing it with a specific temperature reference in the control box. Deviations from predetermined limits result in further correction by the actuator.

If you have electromechanical systems requirements—for aircraft, missiles or ground support equipment—we will be happy to make a proposal. Often we can meet requirements with an Airborne standard or modular system. If not, we are fully qualified to develop custom designs, as in this instance. New Catalog GC-60 gives further information. Contact any of our offices.

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## NEW PRODUCTS

### Power Supply

630

Provides 0 to 18 v at 0 to 1.5 amp



Model 855 transistorized power supply has a continuously variable output of 0 to 18 v at 0 to 1.5 amp. Regulation for load or line is less than 5 mv and ripple is less than 500  $\mu$ v. Internal impedance is low over a wide frequency band. The unit can be operated in series or parallel. Remote programming is possible. Line input is 105 to 125 v ac at 50 or 440 cps.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N.J.  
Price: \$175, including case.

### Frequency Standard

632

Accuracy is  $\pm 0.1\%$  at 25 C



Model JF400 frequency standard is a tuning-fork oscillator consisting of an electronically driven tuning fork and output filter. Standard units are supplied for 400 cps; other frequencies can be furnished. Accuracy is  $\pm 0.1\%$  at 25 C. The instrument is complete with a power supply for operation from 115 v at 60 cps.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N.Y.  
Price: \$89 ea.

### Analog-to-Digital Converter

675

Has three-decimal digit output

Model 301 analog-to-digital converter converts any input of  $-0.999$  v full scale to three decimal digits with an over-all accuracy of  $\pm 1$  digit or  $\pm 1$  mv. Conversion time is 1 msec for any input.

## revolutionizes soldering!



No other solder provides the performance advantages of ALPHA Cen-Tri-Core Energized® Rosin-filled Solder because no other solder is made this way.

ALPHA Cen-Tri-Core's center wire is rosin coated then inspected visually before an extruded outer sleeve is added. Result? Every inch of its "core within a core" construction is filled with fast-acting, non-conductive flux. Meets federal specifications QQS-571C. Write for details.

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In Chicago, Ill.:  
ALPHALOY Corp., 2250 S. Lumber St.

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**alpha**  
**metals** INC.  
58C Water St.,  
Jersey City 4, N. J.

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## EXPANDED TEFLON TUBING



## THAT SHRINKS TO FORM A TIGHT FIT!



IT IS USED:

- To encase irregular shapes
- To protect electrical components
- To obtain tight fits over rollers and machined parts
- To join chemical tubes and metal fittings, etc.

PF Teflon-TFE tubing, which has been expanded mechanically, will recover the original dimensions promptly and clamp tightly to the inserted object when heat is applied. This new PF tubing:

- retains the outstanding electrical, mechanical and chemical properties of Teflon
- is available in all popular sizes, in both thin and standard walls, in 11 basic colors, printed and cut to the lengths you require
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**P** This new Teflon tubing will fit your critical requirements. Get complete details today. Write, wire or call.

**PENNSYLVANIA FLUOROCARBON CO., INC.**  
1115 N. 38TH STREET, PHILADELPHIA 4, PA.  
PHONE: EVergreen 6-0603 TWX: PH 252

\*Du Pont Reg. T.M.

CIRCLE 86 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • August 17, 1960

Of modular construction, the instrument consists of a rack-mounting card file which contains plug-in printed circuit computer elements, including the power supply and reference voltages.

Ransom Research, Dept. ED, 323 W. Seventh St., San Pedro, Calif.

## Slide-Lock and Chassis Slides 628

For electronic assemblies



The positive slide lock, capable of standing shock and vibration, does not unlock unless manually released by means of a rod-release button which is an internal part of the lock. The chassis slides are made of high-tensile, heat-treated, anodized aluminum with ball spacers, ball bearings, and stop pins of stainless steel. Weight capacities range from 50 to 500 lb per pair; lengths are 10 to 68 in. Both the lock and the slides meet Mil specs for shock and vibration.

Grand Sliding Mechanisms, Inc., Dept. ED, 2401 W. Ohio St., Chicago 12, Ill.

*Availability: Delivery is in three to five weeks.*

## X-Band Magnetron 514

Frequency range is 8,600 to 9,500 mc



Type L-3305 X-band magnetron can be hydraulically tuned at rates to 100,000 mc over the frequency range of 8,600 to 9,500 mc. Pulse stability at peak power output of better than 65 kw is maintained. The unit stands severe shock and vibration.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.

## SOLVING MATERIAL DESIGN PROBLEMS FABRICATING



**Buy the parts not the problems.** From large and unusual shapes to parts so small you inspect with a jeweler's glass... CDF's special fabricating facilities can do your job faster, more economically. Every part shown above is fabricated by CDF, except the etching of the printed circuits.

There's an excellent chance you can save on set-up and production time, and reduce unit costs by asking CDF to give you an estimate on final fabrication of laminated plastics, vulcanized fibre and electrical insulating materials.

Our machines, all 2,000 of them, are set up for just one purpose—the forming, machining and molding

of the many types of materials that we produce.

Most important of all, you can combine economy with the exact properties you're looking for. CDF offers you a choice of materials from the industry's widest selection of laminated plastics, vulcanized fibre and electrical insulating materials. Check your Sweets PD file or write for General Folder 60.



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**Machining** low-cost tracks for sliding glass doors. Made by CDF from Diamond vulcanized fibre. It's tough, yet light in weight.

**Molding** automobile timing gear blanks made from CDF's Celoron molding material for maximum wear and a minimum of noise.

**Postforming** back-up disc for a sander. Made from a Dilecto laminated plastic to get maximum toughness and resiliency.

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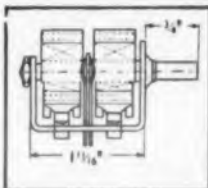
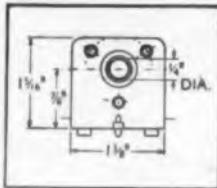


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Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. 15 3/4" x 21 1/2" x 15". 150 lbs. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, N.H., U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario.

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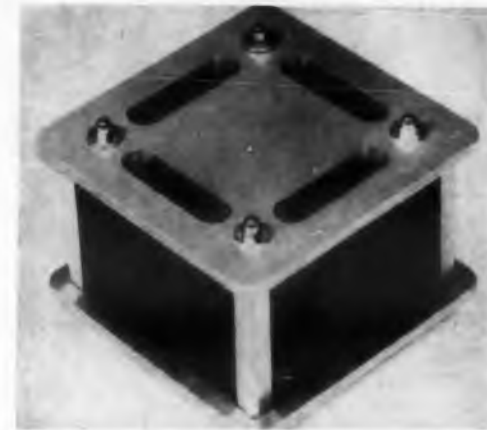
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WOrth 2-5485

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**NEW PRODUCTS****Memory-Core Stacks**

Range is 256 to 16,384 words

623



This line of 50-mil OD memory-core stacks is for use in coincident-current, transistorized computers. They are offered in any wiring configuration with switching times as low as 0.3  $\mu$ sec and drive currents as low as 360 ma. Word range is 256 to 16,384 words.

Ferroxcube Corp., of America, Dept. ED, Saugerties, N.Y.

Price & Availability: \$100 ea and up; 30-day delivery.

**Ku-Band Amplifier**

Range is 12 to 18 kmc

365



The HA-46 Ku-band amplifier has a frequency range of 12 to 18 kmc. Using four anodes, it has a saturation power of 1 mw and a small-signal gain of 25 db. Noise figure for broad-band operation is 12 db. Length is 15-3/4 in., and capsule diameter is 1-1/16 in. The unit weighs 1-3/4 lb. Ku-band waveguides with UG-419/U flanges serve as input and output connectors. It is focused with a 1000 gauss solenoid. Maximum helix-collector voltage is 1300 v.

Huggins Laboratories, Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.

**Self-Locking Fasteners**

Retains wires to terminal boards

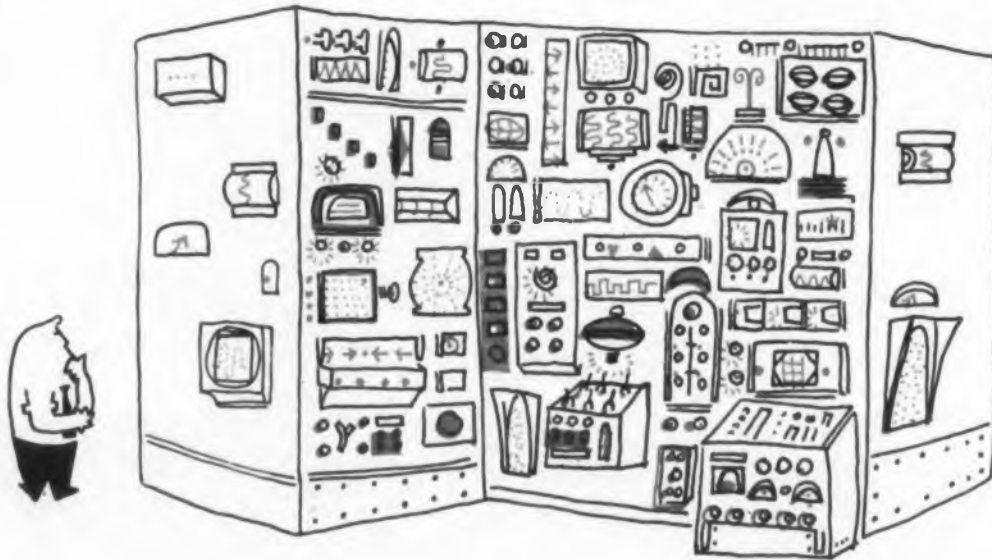
520

These self-locking fasteners retain wire leads to terminal blocks despite shock and vibration conditions that would loosen regular threaded connections. MIL specs are met.

Nylok Corp., Dept. ED, 133 Penn St., El Segundo, Calif.

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. . . the digital computer. The August 31st issue of *ELECTRONIC DESIGN* will show the wide scope of actual applications of computers in design work. You'll learn how many fellow designers have used the computer to solve problems . . . you'll learn how it may solve yours.

Consider the computer. See the next issue of *ELECTRONIC DESIGN*.

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### GENERAL SPECIFICATIONS

Available from .01 mfd. to 10 mfd.  
 Accuracy: .01%  
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 BURBANK, CALIFORNIA

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## Multimeter

497

All-electronic, solid state



Model 843 all-electronic, solid-state multimeter measures dc volts, dc ratios, ac volts, and resistance. Ranges are:  $\pm 0.00001$  to 0.09999, 0.9999, 9.999, 99.99, and 999.9 v dc; dc ratios from  $\pm 0.0001$  to 0.9999, 9.999, and 99.99 v; 0.0001 to 0.9999, 9.999, 99.99, and 999.9 v ac; and 0.1 to 999.9 ohms, 9.999, 99.99, 999.9 K. Reading time for dc voltage measurements, for example, is 50 msec. A Zener diode bridge provides temperature stability and drift characteristics of better than 0.005%. The instrument has Nixie readout and a life of 10,000 hr.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

**Price & Availability:** Price is \$5350 ea; Units will be furnished from stock by July 1, 1960.

## Signal Generator

510

Range is 50 kc to 900 mc



Model SP-120 signal generator is capable of producing up to fixed-frequency cw signals in the range of 50 kc to 900 mc. The unit uses a separate crystal-controlled oscillator-amplifier for each frequency generated. A switch on the master control chassis permits the operator to instantly select the chassis involved. An automatic-gain-control circuit holds the output to a precise level. The rf output is over 2 v rms into 50 ohms and rf leakage is below 1  $\mu$ v.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

**Price & Availability:** \$2000 to \$2500 ea plus \$75 to \$600 for plug-in oscillator units. Delivery is in 60 to 75 days.

**It's  
 about  
 time**

*Whether an interval is a month or a microsecond, you can measure it, divide it, record it, or use it for control with an A. W. Haydon Company custom-designed or standard timer. Every type, every size, every class... timing motors, time delay relays, interval timers, repeat cycle timers... you name it, we make it. If you ever have a specific timing problem, the least you can do for yourself is get our literature. In fact, why not send for our Bulletin on the 14100 Series DC Motor (above) right now. This two-ounce sub-miniature DC Timing Motor is less than 1" in diameter, 1 1/8" long. Used to drive a miniature tape recorder in the Vanguard II weather satellite (expected to remain in orbit for 200 years), it represents the high capability of The A. W. Haydon Company in timing devices.*

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221 North Elm St., Waterbury, Connecticut

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YOU CAN SPECIFY savings in weight, improvements in performance, increases in reliability for your electronic systems from this box. This is Sperry's Speci-File—a complete electronic and physical biography of the traveling wave and klystron tubes offered by Sperry Gainesville. To speed your specifying, to make it more accurate, and to secure the benefits of outstanding microwave tube performance for your systems, order your free Sperry Speci-File today. Just fill in and mail the attached coupon.



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## NEW PRODUCTS

### Klystron Power Amplifier

512

Range is 7.125 to 8.5 kmc



Model 210A 2-kw, rf klystron power amplifier is for use from 7.125 to 8.5 kmc in such applications as high-power, point-to-point communications; tropospheric scatter; and other microwave applications. Four klystron tubes are used in the unit. It has a gain of better than 40 db when operated with a broadband amplifier. All circuitry is housed in one cabinet measuring 84 x 44.5 x 27 in. The heat exchanger is separate.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Drive, Menlo Park, Calif.

*Availability: Units are made on order.*

### Silicon Mesa Transistors

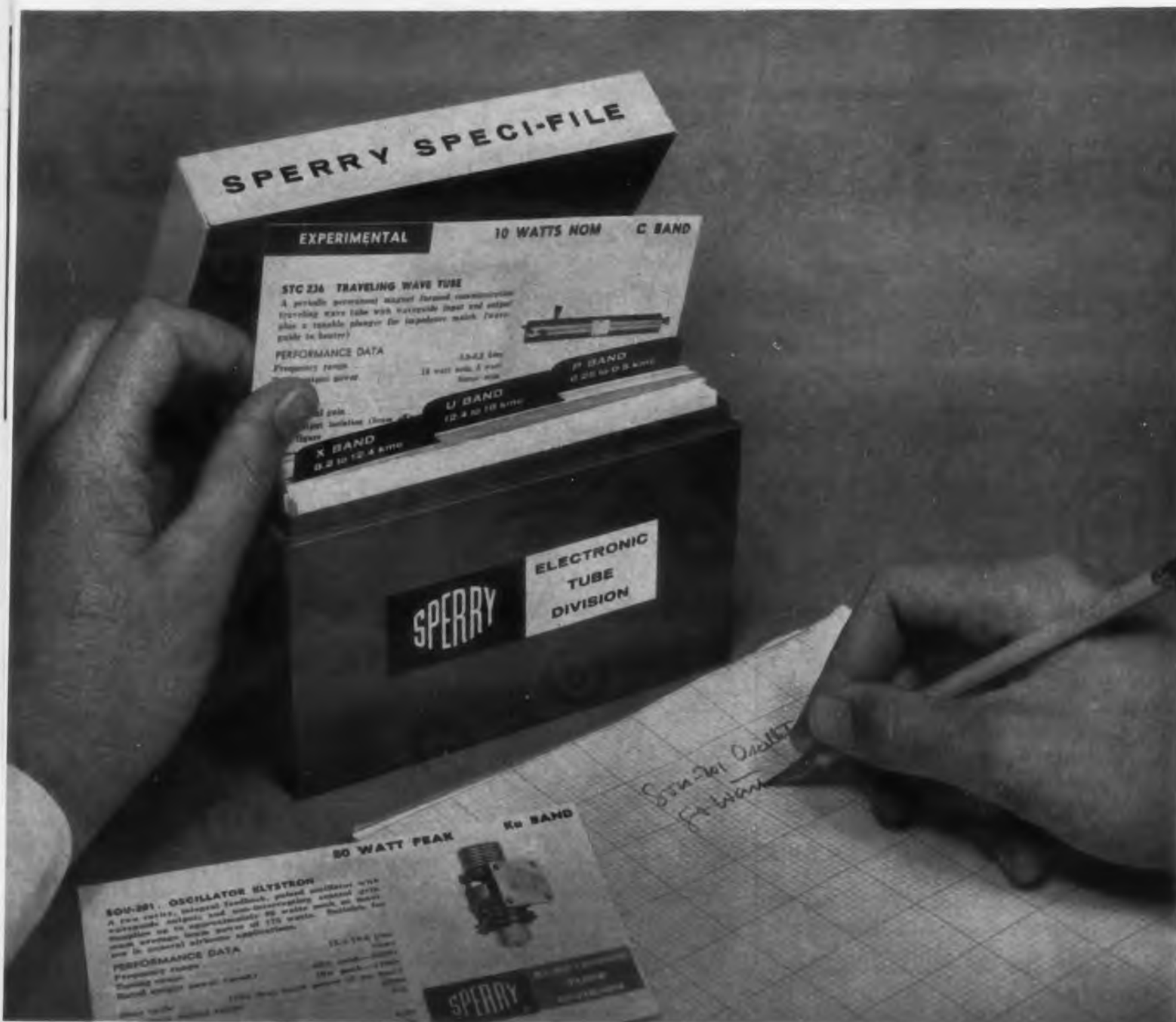
452

For hf and vhf applications

Types 2N1491, 2N1492, and 2N1493 medium-power, silicon mesa npn transistors have the following respective alpha-cutoff frequencies at an  $I_c$  of 15 ma: 250, 275, and 300 mc. The collector-to-base ratings are 30, 60, and 100 v. For all three units, the dissipation rating in free air at 25 C is 0.5 w and with a heat sink, 3 w. Temperature range is -65 to +175 C. They are designed for oscillator, driver, and large-signal, power amplifier service and provide a minimum useful power output of 0.5 w at 70 mc. Types 2N1492 and 2N1493 deliver 10 mw at 250 mc with a typical gain of 6.5 db.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

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## Memory Core Testers 405

For all stages in core manufacture

These memory core testers cover all stages of core manufacture. Type 2101 automatic tester, for production line testing, operates at a rate of 3 cores per sec. Experimental stage testing is provided by a single-core memory tester, designed to evaluate individual cores. Cores assembled into coincident-current or word-address planes and stacks are automatically tested by the 1512 and 1514 units. Complete memory systems can be tested under simulated computer conditions with type 1513.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

**Price & Availability:** Price is about \$17,000 for type 2101. Delivery time is 90 days.

## Transducer Conditioner 536

For single-channel measurements

For laboratory or field use, model 1-110T strain-gage transducer conditioner and power supply is designed for single-channel measurements. It is suitable for calibrating transducers prior to installation in data acquisition systems. The transducer is a four-arm type. Two sets of 10, 30, 50, and 100 K calibration resistors are furnished. Input wiring is 4, 6, 7, or 8 wires.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

**Price & Availability:** Price is \$275; delivery time is 30 to 45 days.

## Silicone Tapes 421

Withstands -110 to +1000 F

These silicone pressure-sensitive insulating tapes can be used from -110 to +1000 F. They are suitable for aircraft, missile and electronic applications where extreme temperatures are encountered.

Mytik Adhesive Products, Inc., Dept. ED, 2635 N. Kildare Ave., Chicago 39, Ill.



# NOW... PSI MICRO-DIODES PRICED THE SAME AS CONVENTIONAL DIODES

Silicon Micro-Diodes (1/50 the size of conventional diodes) are now available at the same price as their larger counterparts. They include the electrical equivalents of several widely used types:

HIGH SPEED MESA COMPUTER DIODES—1N904 • 1N914. GENERAL PURPOSE COMPUTER DIODES—1N643 • 1N658 • 1N663. LOW LEAKAGE SILICON DIODES—1N457 • 1N458 • 1N459...and a new high voltage series to 1.2 kilovolts.

Additionally, Pacific Semiconductors, Inc. has recently introduced a series of Micro-Transistors designed as companion components. These include electrical equivalents of transistor types 2N696 and 2N697.

### RELIABILITY ≥ CONVENTIONAL DIODES

These Micro-Diode types meet or exceed all environmental requirements of MIL-S-19500B.

1. MOISTURE RESISTANCE: MIL-STD-202A, method 106A.
2. TEMPERATURE CYCLING: Ten 15-minute cycles—65°C to 200°C.
3. THERMAL SHOCK: MIL-STD-202A, method 107, test condition C (-65°C to 200°C).
4. CONSTANT ACCELERATION: More than 20,000 G.

For details on life testing and reliability curves, write today for "Micro-Diode Reliability Study."

*Pacific Semiconductors, Inc.*

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12955 Chadron Avenue, Hawthorne, California



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## NEW PRODUCTS

### Positive Clutch

511

Over-all length is 3/4 in.



Type CT 14 positive clutch, measuring 1-1/2 in. in diameter and 3/4 in. in length, is for instrument applications. It develops 80 oz-in. torque and may be wound for 28 v dc. A sheave may be mounted on the driven hub which serves as an armature; other types of mountings are with worm gears and spur gears.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

*Price & Availability: List price is \$202 ea, subject to OEM discount. Delivery time is three weeks.*

### Data Amplifier

364

Transistorized



Type 491 data amplifier has gains of 100, 250, 500 or 1000 that will not vary more than 0.01% during 1000 hr of operation. Input impedance is 300 K and output impedance, less than 0.1 ohm. Response to step input is 99.7% in 0.0025 sec. Common mode rejection of dc signals is infinite; rejection at 60 cps is 120 db. Up to 250-v, common-mode signals may be applied. Output ripple is not over 10 mv rms. Amplifier modules are 2-1/8 in. wide and 14-1/2 in. deep. Each unit requires +15 v dc at 150 ma, -15 v dc at 75 ma and 6 v, 400 cps at 30 ma.

Offner Electronics Inc., 3900 River Road, Schiller Park, Ill.



## THE NEW BONDEZE® WIRE

### FOR SELF-SUPPORTING COILS... PHELPS DODGE

# Bondeze®

*A self-bonding wire—now  
with improved and added properties!*

**Improved in three important ways:**

- Extra resistance of underlying film to temperature-pressure "cut-thru." Reduces shorts.
- Cracking negligible when solvent bonded.
- Underlying film gives better thermal life.

**... and with this newly added property:**

- Easy solderability . . . solders or dip-tins at low temperatures without cleaning or stripping. No damage to copper conductor.

Phelps Dodge S-Y Bondeze® magnet wire bonds turn to turn with a single application of heat or solvent. This important property, combined with improved thermal characteristics and easy solderability, opens a new and wider range of applications for self-supporting coils or bobbin-less coils and windings.

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

FIRST FOR  
LASTING QUALITY  
—FROM MINE  
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS  
CORPORATION**

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA

CIRCLE 95 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Rate Gyro

629



For flight-test  
applications

Model 36128VN dc-powered rate gyro for flight-test applications measures 2 x 4 in. The package contains a miniature, transistorized power inverter to eliminate the need for commutators, brushes, slip rings, and governor contact points. Useful motor life is more than 1000 hr. The gyro inverter can also be used as a source of 400-cps power for other gyros and frequency-sensitive devices. Frequency is controlled to  $\pm 1\%$  over the standard temperature range of  $-65$  to  $+165$  F, with input varying from 24 to 31 v dc. Ranges are from  $\pm 15$  to  $\pm 1000$  deg per sec.

Giannini Controls Corp., Dept. ED, 918 E. Green St., Pasadena, Calif.

*Availability: Delivery can be made within 45 days.*

## Shift Register Element

406

Measures 1/2 x 1/2 x 7/16 in.



The Microbit magnetic shift-register element measures 1/2 x 1/2 x 7/16 in. It requires less than 150-mw peak power to advance a 1-signal from stage to stage of the register. One 200-mw transistor will drive 20 register bits. The elements operate over 0-to-250-kc repetition rates at 100% duty cycle. Units can meet military specifications for temperature.

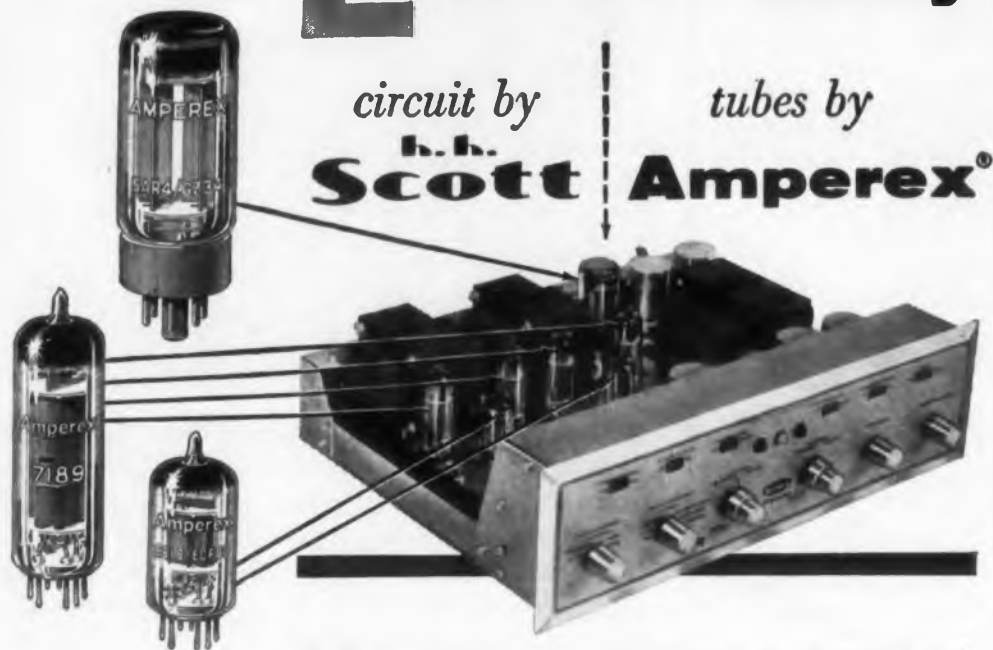
Magnetics Research Co., Inc., Dept. ED, 255 Grove St., White Plains, N. Y.

*Availability: Delivery is from stock to 30 days.*

101



# 2 for the money



H. H. Scott engineers, preliminary to the design of their Model 299 (40 Watt) Complete Stereo Amplifier, canvassed the industry for tube types offering something truly exceptional in the way of reliability, low distortion, low noise, low hum and absence of microphonics.

As has frequently been their experience, the people at Scott found these qualities best exemplified by Amperex tubes. Thus, the tube complement of the Scott Model 299 includes four Amperex 7189's, one Amperex 5AR4/GZ34, and two Amperex 6BL8/ECF80's.

These and many other Amperex 'preferred' tube types have proven their reliability and unique design advantages in the world's finest audio components.

Applications engineering assistance and detailed data are always available to equipment manufacturers. Write: Amperex Electronic Corp., Special Purpose Tube Division, 230 Duffy Ave., Hicksville, Long Island, New York.



ask Amperex  
about hi-fi tubes  
for hi-fi circuitry

## OTHER AMPEREX TUBES FOR QUALITY HIGH-FIDELITY AUDIO APPLICATIONS

### POWER AMPLIFIERS

- 6CA7/EL34: 60 w. distributed load
- 7189: 20 w., push-pull
- 6BQ5/EL84: 17 w., push-pull
- 6CW5/EL86: 25 w., high current, low voltage
- 6BM8/ECL82: Triode-pentode, 8 w., push-pull

### RF AMPLIFIERS

- 6ES8: Frame grid twin triode
- 6ER5: Frame grid shielded triode
- 6EH7/EF183: Frame grid pentode for IF, remote cut-off
- 6EJ7/EF184: Frame grid pentode for IF, sharp cut-off
- 6AQ8/ECC85: Dual triode for FM tuners
- 6DC8/EBF89: Duo-diode pentode

### RECTIFIERS

- 6V4/EZ80: Indirectly heated, 90 mA
- 6CA4/EZ81: Indirectly heated, 150 mA
- 5AR4/GZ34: Indirectly heated, 250 mA

### VOLTAGE AMPLIFIERS

- 6267/EF86: Pentode for pre-amps
- 12AT7/ECC81: } Twin triodes, low hum,
- 12AU7/ECC82: } noise and microphonics
- 12AX7/ECC83: }
- 6BL8/ECF80: High gain, triode-pentode, low hum, noise and microphonics

### INDICATORS

- 6F66/EM84: Bar pattern
- IM3/DM70: Subminiature "exclamation" pattern

### SEMICONDUCTORS

- 2N1517: RF transistor, 70 mc
- 2N1516: RF transistor, 70 mc
- 2N1515: RF transistor, 70 mc
- IN542: Matched pair discriminator diodes
- IN87A: AM detector diode, subminiature

CIRCLE 96 ON READER-SERVICE CARD

## NEW PRODUCTS Switch Light

496



With neon or incandescent lamp

Type 6DR switch light can be furnished with neon or incandescent replaceable lamps. It is a push-to-test, non-snap, normally-open, momentary-contact type. Rating is 0.5 amp at 115 v ac and life expectancy is 1,000,000 cycles. The lamp leads and switch terminals are brought out separately in a four-pin base socket. Mil specs are met.

Eldema Corp., Dept. ED, 1805 Belcroft Ave., El Monte, Calif.

Price & Availability: \$3.79 ea in quantities of one to 19. Delivery from stock.

## Ceramic Printed Circuits

367

Withstand 1800 F



Ceramic printed circuits with high alumina bodies and moly-manganese circuits stand high humidity and corrosive environments as well as temperatures up to 1800 F. The circuits, protected with a nickel or copper coating to serve as solder base, can be mass-produced in sizes from 0.125 x 0.125 x 0.008 in. to 3 x 6 x 0.06 in. Components can be hermetically sealed to the faces. Tolerances of  $\pm 0.005$  in. for screened patterns and  $\pm 0.001$  in. for hole centers are held.

Mitronics Inc., Dept. ED, 1290 Central Ave., Hillside, N. J.

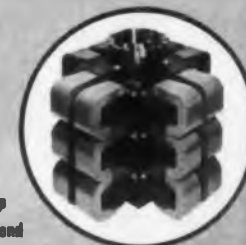
## Think Clean

When you think of high vacuums, you have to think clean... and if you think of exceptionally clean vacuums, without fluids or other contaminants, you have to think of UlteVac electronic vacuum pumps — made by Ultek, the only manufacturer devoted exclusively to the technology of fluidless vacuum pumping. UlteVac pumps, using no moving parts, hot filaments, or refrigeration, produce vacuums to  $10^{-9}$  mm Hg and below; operate unattended for months, invulnerable to power failure. System vacuum automatically measured.



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VACUUM  
PUMPS

1 to 1000 Liters/Second



Series 327 Pump  
270 Liters/Second

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- METAL SEAL FITTINGS
- FULL CONDUCTANCE VALVES
- AMBIENT FORELINE TRAPS

Literature available (state application) from Ultek or its exclusive sales representative, Kinney Mfg. Div. of the New York Air Brake Co. Sales Offices in major U.S. cities.



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CIRCLE 97 ON READER-SERVICE CARD

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Price &  
ELECTRO

## Microwave Oscillator

411

Has plug-in generator heads



Model 605 microwave oscillator has plug-in type generator heads. Each generator head consists of a BWO tube and solenoid; it is inserted into a recess in the rear of the oscillator. Heads are available in these standard sizes: 2 to 4 kmc, 4 to 8 kmc, 8 to 12.4 kmc, 6.5 to 11.5 kmc, and 12.4 to 18 kmc. The sweep frequency of the oscillator is adjustable from 0 to bandwidth extremes with an accurate, direct-reading, slide-rule dial. Two frequency markers are provided for broadband calibration of an oscilloscope or recorder trace. Residual fm is  $\pm 0.0025\%$  and minimum drift is  $\pm 0.02\%$ .

Alfred Electronics, Inc., Dept. ED, 897 Commercial St., Palo Alto, Calif.

Price: \$1750 ea for the oscillator; \$1590 to \$1990 ea for the heads.

## Digital Readout

407

Operates from binary output



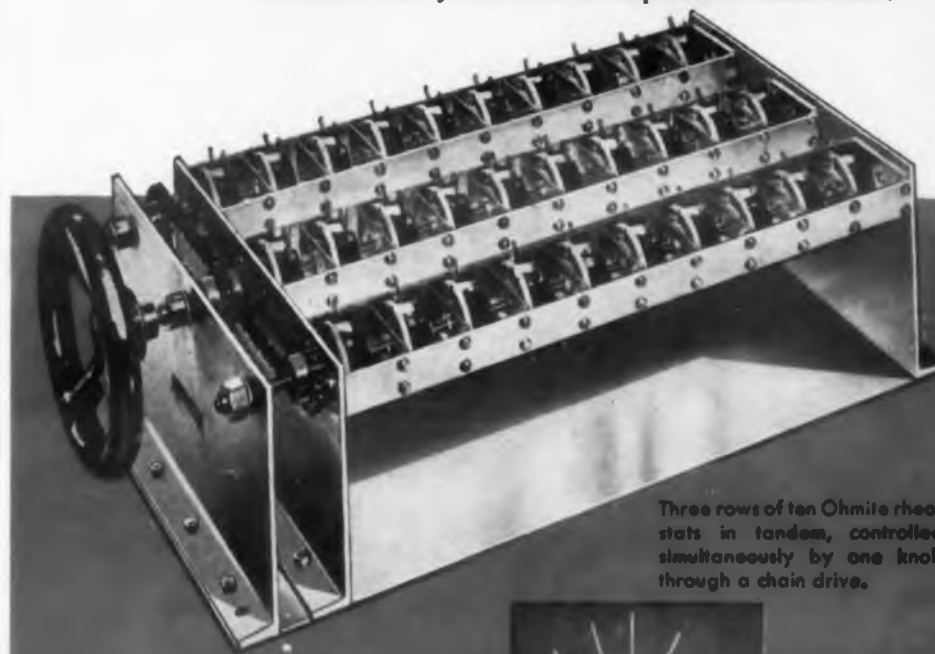
Called the Slide Plate Readout, this device operates directly from the binary input, eliminating the need for a decoding device. The unit automatically decodes any BCD code up to six bits into numeric, alphabetic, or special symbols. It can be used with computers, test equipment, and other systems. Contained in the unit are 16 character plates. Modular construction is used and dimensions are 3-1/4 x 1-13/16 x 7 in.

Industrial Electronic Engineers, Inc., Dept. ED, 5528 Vineland Ave., N. Hollywood, Calif.

Price & Availability: \$40 ea; 30-day delivery.

# OHMITE RHEOSTATS WITH SPECIAL FEATURES solve many difficult control problems

Ohmite offers not only industry's most complete line of standard rheostats but also rheostats with a wide variety of special features. Illustrated are only a few. All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel. You will find the special rheostat feature you need in the dependable Ohmite line.



Three rows of ten Ohmite rheostats in tandem, controlled simultaneously by one knob through a chain drive.

Ohmite rheostats can be mounted with two, three, or more in tandem for operation by one knob. Controls several circuits simultaneously. Model H and miniature Model E rheostats in tandem save panel space.



Rheostat with tapped winding and sensitive switch, arranged to operate at any preselected position of contact arm.



Example of a 360° rotation rheostat with a wire lead tapped winding.



Locking type bushing with screw-driven slotted shaft.



Typical Ohmite motor-driven tandem rheostat assembly.



Two groups of four Ohmite taper-wound rheostats mounted in tandem, controlled by a single knob through a chain drive.

Call on Ohmite for APPLICATION ENGINEERING SERVICE

Save valuable engineering time. Team up with Ohmite to solve your resistance problems. Ohmite engineers are resistance specialists. They can quickly analyze your needs and recommend the correct rheostat to fit your application.



Write on company letterhead for Catalog 58.

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

CIRCLE 98 ON READER-SERVICE CARD



## NEW PRODUCTS

### Meter 507

Has 0.2  $\mu$ a sensitivity

Sensitivity of the model 700 meter is 0.2  $\mu$ a, full scale. The unit has better than 1/4% accuracy, up to 23 ranges, and circuitry that enables it to stand overload surges to 125,000,000% in some cases. Over-all dimensions, with carrying case, are 5-7/8 x 8-1/2 x 11-3/4 in. The instrument's suspension movement absorbs shock up to 500 g.

Greibach Instruments Corp., Dept. ED, 315 North Ave., New Rochelle, N. Y.

### DC Amplifier 358

Accepts 5  $\mu$ v to 1 v

Model 759-6 dc amplifier accepts signals from 5  $\mu$ v to 1 v. Having an inherent accuracy of 0.25% and a stability of 5  $\mu$ v, the unit is suited for general laboratory work or for measurement of data produced by thermocouples, strain-gage transducers, and potentiometers. It consists of a high-impedance input circuit completely isolated from ground, a chopper amplifier, a 2-tube vacuum-tube amplifier, and a chopper demodulator. It is capable of indicating on a panel meter or recording on a meter-type recorder. A power supply is built-in. Weight of the unit is 10 lb.

Magnetic Instruments Co., Dept ED, Thornwood, N.Y.

*Price: Without panel meter, \$179.50; with panel meter, \$199.50.*

### Temperature Controls 444

Transistorized

Series 536 temperature controls are transistorized and employ factory-calibrated thermistors. The unit controller, for example, covers a range of -50 to +600 F, has a sensitivity of 0.3 F, and provides either on-off or proportioning action. Its current handling capacity is 10 amp at 110 v ac and 5 amp at 230 v ac.

Fenwal, Inc., Dept. ED, Pleasant St., Ashland, Mass.



General Electric takes the tubulation of

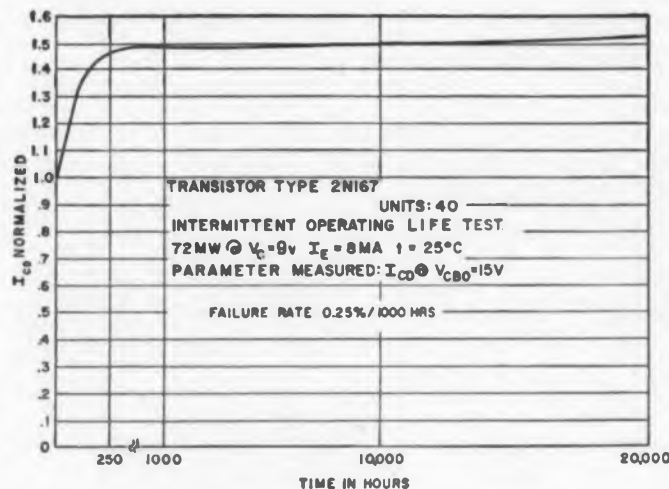
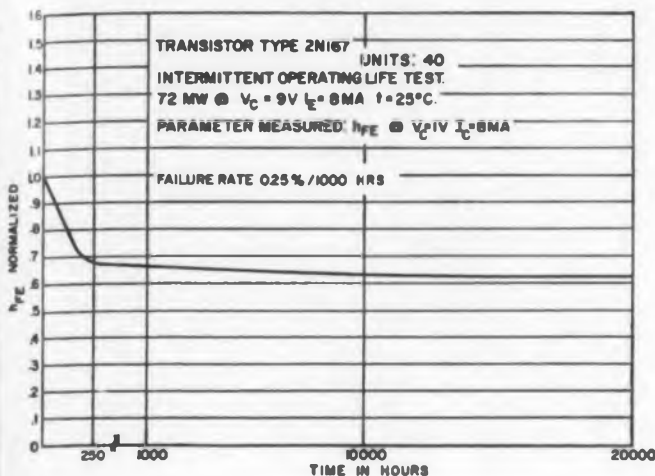
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ELECTRO

## General Electric transistors hold the record in rate-grown reliability

General Electric has manufactured millions of rate-grown transistors in the past seven years. As a result of this experience, G.E.'s parameters are exceptionally stable and a vast amount of reliability data has been accumulated, some of which is shown here. These curves cover 29 lots of General Electric 2N167, tested to MIL-T-19500/11.



The rate-grown process produces a small, clean junction which exhibits almost no drift or deterioration at high voltages and offers the user low  $I_{CO}$  and  $I_{EO}$ . Two new types, the 2N1510 and 2N1217, will be useful for low-level switch and neon indicator applications. Both the 2N1217 and 2N167 operate at extremely low current and leakage levels, making them ideal for starvation circuits of 2 ma or less.

## off rate-grown NPN transistors!

Remove the tubulation (pinch-off) from rate-grown transistors without sacrificing reliability? General Electric has done just that and even improved reliability with stabilized beta and collector cutoff current. Prices have been reduced on some types up to 20%.

Removal of the tubulation was made possible by adding a sieve or getter. Improved beta and collector cutoff current results from a 125-hour 85°C bake, which also improves the paint's resistance to solvents and chipping. Pellet, pellet mount and processing are identical to the previous process before encapsulation. Then a sieve is added rather than evacuation and subsequent pinch-off. The sieve is the same used and proved for years on G.E.'s PNP low-frequency 2N525 and PNP high-frequency 2N396 lines.

The high-reliability 2N78A and 2N167A have guaranteed 71°C  $I_{CO}$  and tight AQL's. The 2N78A also features a 20 volt  $BV_{CEO}$  rating compared with the 2N78's 15 volts. The 2N167A, in addition to 71°C  $I_{CO}$ , has a lower  $I_{EO}$ . For more information, see your G-E Semiconductor Sales Representative or Authorized Distributor. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

**ADVANTAGES TO YOU:** 40% lower height • Reduced prices • Stabilized  $I_{CO}$  and  $h_{FE}$ . All units baked 125 hours at 85°C • Greater resistance of paint to solvents, chipping, and salt spray • Improved low-temperature performance and reliability.

Type No.	Maximum Ratings				Electrical Parameters					
	P <sub>c</sub> mw @ 25°C	BV <sub>CE</sub> BV <sub>CS</sub>	I <sub>c</sub> ma	T <sub>J</sub> °C	h <sub>FE</sub>	MIN @ I <sub>c</sub> ma	MIN f <sub>a</sub> mc	MIN G <sub>c</sub> db	MAX I <sub>co</sub> (μa) @ V <sub>CS</sub>	
2N78	65	15	20	85	45	1	5	27	3	15
2N78A	65	20	20	85	45	1	5	29	3	15
2N78A (Cert)	65	20	20	85	45	1	5	29	3	15
2N167	65	30	75	85	17	8	5	—	1.5	15
2N167A	65	30	75	85	17	8	5	—	1.5	15
USAF2N167A (per MIL-S-19500/11)	65	30	75	85	17	8	5	—	1.5	15
2N169A	65	15	20	85	34	1	—	27	5	15
2N1198	65	25	75	85	17	8	5	—	1.5	15
2N1217	65	20	20	85	40	2	5	—	1.5	15
2N1510	75	75	20	85	8	1	—	—	5	75

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# GENERAL ELECTRIC

CIRCLE 99 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Pressure Switches

494



Operate from 5 to 1,000 psi

Type 6621 pressure switches are for operation at a fixed pressure from 5 to 1,000 psi; they operate over the temperature range of -65 to +275 F, and stand up to 2,000 cps vibration. For use in fuel, hydraulic, and other applications, the switches can have the following contact arrangements: spdt, normally open; spst, normally open; and spst, normally closed. Contact ratings are: at 30 v dc, 2.5 amp inductive or 5 amp resistive at 50,000 ft; at 125 or 250 v ac, 5 amp.

Consolidated Controls Corp., Dept. ED, Bethel, Conn.

**Price & Availability:** Price is \$75 ea in quantities of one to nine. Delivery time is 60 days.

## Clocks

493

Oscillator and slave types



Model OC-10 oscillator clock and model SC-10 slave clock are for use in the model BL-11 digital module cabinet. The oscillator clock has a crystal-controlled oscillator providing 1-mc pulses to the BL-11 and a synchronizing drive to 1 to 14 slave clocks. Power requirements are -16 v dc ±10% at 25 ma; frequency is 1,000 kc ±0.02%. The slave clock is like the OC-10 but without the oscillator. It incorporates a fuse in series with the -16 v supply to protect the BL-11. Power requirements are -16 v dc ±10% at 6 ma.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

**Price & Availability:** OC-10, \$138 ea; SC-10, \$71 ea. Delivery is from stock.

105





60 cycle A.C. blower  
with  
60 decibel rating

### For those applications requiring long life and low sound levels.....

the Dean and Benson quiet blower series provides a blending of these essential characteristics. Our research and development have accomplished this with no compromise in efficient performance. Whatever your performance, life or sound specification — the quiet series has the answer already solved and waiting for you. When your next cooling problem arises, remember 60 for the 60's.

All models available with 110, 220, or 440 volt motors. Call our experienced sales engineering staff to discuss your requirements today.

Write for your copy of our new **Engineering Handbooks** on the following:

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- B** 60 cycle A.C. Blower Series    **D** 2" POWAIR Blower Series



### DEAN & BENSON RESEARCH

Division of Benson Manufacturing Co., Kansas City 1, Mo.  
• Blowers • Heat Exchangers • Cooling Systems

CIRCLE 100 ON READER-SERVICE CARD

## NEW PRODUCTS

### Data Amplifier

487



Gain accuracy is  
0.01%

Type 492 two-channel, transistorized data amplifier has a gain accuracy of 0.01%. A true differential input amplifier, the unit can have several hundred volts applied between the input and ground without interference. Gain is 100, 250, 500, or 1000 +2% and is selected by a panel switch. Output impedance is less than 0.1 ohm, input impedance is 300,000 ohms, and source impedance is 1000 ohms max for nominal characteristics. Two amplifiers are contained in each module; a total of 16 channels can be mounted in 8.75 in. of rack space.

Offner Electronics Inc., Dept. ED, 3900 River Road, Schiller Park, Ill.

### Power Supplies

609

Regulation is 0.01%



Rated at 1 to 10.01 kv at 0 to 10 ma, model 410 A power supply has a regulation of 0.01%, a stability of 0.005% per hr, and an output ripple of less than 5 mv. An in-line, four-dial readout indicated voltage output to an accuracy of 0.25% with a resolution of 10 mv over the entire range. The unit measures 19 x 12-7/32 x 17 in. and weighs 95 lb.

John Fluke Manufacturing Co., Inc., Dept. ED, P. O. Box 7161, Seattle 33, Wash.

Price: \$1095 fob Seattle.

## THIS IS THE CORRECT EASY WAY



### PEEL

the STANPAT from its backing.



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into position... will not wrinkle or come off.

Don't chain your engineers to time-consuming routine on repetitive blueprint items... free them for more creative work and save countless hours of expensive drafting time with STANPAT.

STANPAT prints these items on tri-acetate sheets that are easily transferred to your tracings. No special equipment required... reproductions come out sharp and clear... and STANPAT is incredibly inexpensive.

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CIRCLE 101 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Amplifier Module

492

Dimensions are 0.237 x 0.475 x 0.24 in.



This three-transistor, RC coupled, printed-circuit amplifier-module measures 0.237 x 0.475 x 0.24 in. or 0.276 x 0.512 x 0.269 in. with a case. Gain is 76 db and frequency response is flat within 3 db from 200 cps to 10 kc. Power output is 0.6 mw into a 600-ohm inductive load with an over-all distortion of 10%. The unit draws 1.9 ma max, operates on a single mercury cell at 1.3 v, and has a noise figure of -43 db at 600 mv output. Uses are in meters, recorders, and other applications. The manufacturer is Viennatone Co. in Vienna, Austria.

Caine Electronic Sales Co., Dept. ED, 4120 W. Lawrence Ave., Chicago 31, Ill.

**Price & Availability:** Price is \$19.58 ea; up to 100 units can be furnished from stock.

## Vibration Tester

682

For quality control analysis

The Rotocon portable vibration tester for quality control analysis reveals substandard missile-borne, electrical, and electronic parts. A fundamental output vibration of 50 cps is provided. The unit is easily operated. In operation there is less than 75 db of noise measured 6 ft from the machine.

Rototest Laboratories, Inc., Dept. ED, 2803 Los Flores, Lynwood, Calif.

**Price & Availability:** \$3,850 ea; delivery time is 30 to 60 days.

## Rotary Stepping Devices

684

All-magnetic

Series 18500 all-magnetic stepper devices are designed for precise angular positioning of rotary components such as potentiometers, dials, and inductors. They may be coupled to synchro transformers or predetermined pulse counters. The units operate on the number of pulses received. They meet or exceed MIL-E-5272C.

A. W. Haydon Co., Dept. ED, 232 N. Elm St., Waterbury, Conn.

**Price & Availability:** \$50 to \$300 ea, depending on enclosure and driver element. Delivery is in eight to 12 weeks.



NEW

*Electra*

METAL FILM  
RESISTOR

with  $0 \pm 150$  ppm temperature coefficient

Now you can get the extreme precision and extreme ruggedness of a metal film resistor at prices up to 60% lower than former costs. Thanks to advanced production techniques, Electra can now offer you a metal film resistor with  $0 \pm 150$  ppm TC in tolerances of 1% and  $\frac{1}{2}\%$  at prices far below those for any other metal film resistor on the market today. This outstanding new resistor is available in the following sizes and ranges:

MF  $\frac{1}{8}$  30 ohms to 500K ohms  
MF  $\frac{1}{4}$  50 ohms to 1 megohm  
MF  $\frac{1}{2}$  50 ohms to 1.5 megohm

Here is a resistor that gives you precision equal to or exceeding the precision of a wire wound resistor, yet it is smaller in size, gives you better RF performance. And now, it is far, far lower in price. Why not write, wire or call now for complete details. (Available with special molded jacket shown or with exclusive Electra R-5 coating.)

**ELECTRA**

4051 Broadway WEstport 1-6864 Kansas City, Mo.

*Manufacturing Company*

CIRCLE 102 ON READER-SERVICE CARD

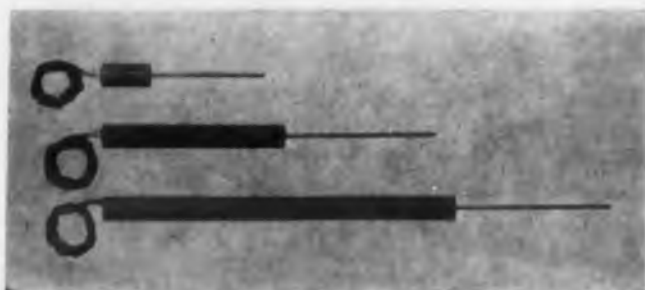


## NEW PRODUCTS

### Rectilinear Transducers

366

Variable-permeance



Type ZD rectilinear transducers are variable-permeance units for use as a position sensor for analytical balances, automatic scale beams, and small meter movements. They are also suited for small displacement vibration sensing. Three models are offered in ranges of 0.1 to 0.8 in. displacement. Both probe and housing are made of stainless steel. Length ranges from 2 to 6.5 in. and housing diameter is 3/8 in.

Crescent Engineering & Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.

*Price & Availability:* \$125 ea and up. Delivery is from stock.

### Temperature-Pressure Readout

471

For industrial monitoring

For applications in industrial monitoring, this system reads out from resistance temperature bulbs in the range of 0 to 1400 F and from resistance pressure transducers in the range of 0 to 10,000 psi. Accuracy is about 0.5% or 2% absolute. Temperature and pressure can be monitored from 99 different points.

Texas Instruments, Inc., Dept. ED. 3609 Buffalo Speedway, Houston 6, Tex.

### Spectrum Analyzer

705

Frequency range is 100 cps to 40 mc


Motorized tuning, a frequency range of 100 cps to 40 mc, and a two-tone audio generator are three of the new design features in the model SSSB-3a single sideband spectrum analyzer. It is used for a variety of ssb and am transmitter and receiver tests. It has a preset sweep rate, gain and optimized resolution at preset sweep widths of 150, 500, 2,000, 10,000 and 30,000 cps. The model TTG-2 two-tone audio generator provides single or dual tones, independently adjustable in frequency from 100 cps to 10 kc ( $\pm 1\%$  accuracy), from 2 to 4 v into matched 600-ohm loads.

Panoramic Radio Products, Inc., Dept. ED, 520 South Fulton Ave., Mount Vernon, N.Y.



# 160B

*Presented proudly*

The  160B—a new 15 MC oscilloscope built to exacting MIL specifications; most versatile oscilloscope ever offered.



Here are some of the outstanding features:

**New plug-in versatility** **Horizontal plug-ins.** New 166 series horizontal (time axis) plug-ins add a whole new dimension of flexibility to the basic oscilloscope. First two of the series are: **166C Display Scanner** making the 160B the world's first major scope with an *X-Y recorder output*. This output covers the full scope bandwidth and makes possible large, high resolution, permanent *X-Y records of repetitive waveforms*. **166D Sweep Delay Generator** establishing new convenience for conventional sweep delay measurements. A unique mixed sweep feature permits detailed analysis of one pulse in a wavetrain while retaining a display (on a slower time scale) of the entire wave preceding the pulse of interest. Thus, you view the exact pulse or segment desired while still retaining presentation of the earlier display. Extremely high magnifications are possible with appropriate settings of sweep controls.

**Vertical amplifier plug-ins.** New 162 series plug-ins will include new amplifiers permitting scope operation under many different input conditions. Typical plug-in is **162A Dual Trace Amplifier**, 20 mv/cm unit permitting simultaneous viewing of two phenomena or differential amplification of signals dc to 14 MC.

**Military quality** — Using premium components throughout, the 160B is designed to meet the highest standards of ruggedness, accuracy and dependability. It follows MIL-E-16400B for shock, vibration, humidity and temperature. Premium features include high stability tube-transistor circuits, regulated dc filament voltages, power transistors in efficient heat sinks, circuits on translucent epoxy-glass, simplified layout.

**Easy to operate** — Model 160B control array is traditional and logical. No special training is required to operate the 160B. Your set-up time and measurements are simplified with improved *preset triggering* and an *automatic beam-finder*. The first means that one preset adjustment insures optimum triggering for almost all conditions (even signals down to 2 mm deflection). The second means that with the press of one button the beam is instantly located and "held" until you center your trace.

## SPECIFICATIONS

### SWEEP GENERATOR:

**Internal Sweep:** 24 ranges, 0.1  $\mu$ sec/cm to 5 sec/cm; vernier to 15 sec/cm  
**Magnification:** 7 ranges, to 0.02  $\mu$ sec/cm  
**Triggering:** 2 mm minimum, internal, power line or vertical input signal. External 0.5 v peak to peak  
**Trigger Point:** Pos. and Neg., -30 to +30 v  
**Sawtooth Output:** -50 to +50 v  
**Gate Output:** 50 v pulse

### HORIZONTAL AMPLIFIER:

**Bandwidth:** dc to 1 MC  
**Sensitivity:** 7 ranges, 0.1 v/cm to 10 v/cm; vernier to 25 v/cm  
**Input Impedance:** 1 megohm, 30 pf shunt

### CALIBRATOR:

**Type:** 1,000 cycle square wave, 1  $\mu$ sec rise, decay time  
**Voltage:** 9 ranges  $\pm$  3%, 0.2 mv to 100 v peak to peak  
**Current:** 5 ma peak to peak,  $\pm$  3%

### CATHODE RAY TUBE:

**Type:** 5AMP mono-accelerator, flat face, P1, P2, F7, P11 screen; 5,000 v accelerating potential  
**Deflection Sensitivity:** 20 v approx.; intensity modulation 20 v pulse to blank  
**PRICE:**  $\text{\textcircled{C}}$  160B Oscilloscope, \$1,850.00

### $\text{\textcircled{C}}$ 162A PLUG-IN AMPLIFIER

**Sensitivity Range:** (Each channel) 0.02 v/cm to 50 v/cm, 10 ranges, 0.02 v/cm to 20 v/cm. Accuracy  $\pm$  5%  
**Pass Band:** Dc coupled, dc to 14 MC, 0.025  $\mu$ sec rise time  
 Ac coupled, 2 cps to 14 MC  
**Differential Input:** Both attenuators may be switched to one channel and adjusted separately. Common Mode Rejection at least 40 db at max sens.; at least 30 db with attenuators  
**PRICE:**  $\text{\textcircled{C}}$  162A Plug-In Amplifier, \$350.00  
 Data subject to change without notice. Prices f.o.b. factory.



## HEWLETT-PACKARD COMPANY

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 Cable "HEWPACK"

Palo Alto, California, U.S.A.  
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HEWLETT-PACKARD S.A., Rue du Vieux Billard No. 1,  
 Geneva, Switzerland

Cable "HEWPACKSA"

Tel. No. (022) 26. 43. 36



## Impedance Comparator

408

For production line testing



Type 1605-AS2 impedance comparator is suitable for production line testing, as well as laboratory use. The system includes a signal source, a bridge circuit, and a detecting circuit. The internal oscillator provides 100 cps, 1 kc, 10 kc, and 100 kc, all  $\pm$ 3%. Full scale ranges are  $\pm$ 0.1%,  $\pm$ 0.3%,  $\pm$ 1%, and  $\pm$ 3% for impedance magnitude and  $\pm$ 0.001,  $\pm$ 0.003,  $\pm$ 0.01, and  $\pm$ 0.03 for phase angle. Accuracy is 3%. The instrument operates from 115 v at 50 to 400 cps.

General Radio Co., Dept. ED, West Concord, Mass.

**Price & Availability:** Price is \$925 ea; small quantities are delivered from stock.

## Silicon Rectifiers

688

For high power applications

The Trinistor controlled rectifiers are three-terminal silicon devices suited for high-power applications up to 300 v at currents to 50 amp. Switching time is 6,000  $\mu$ sec with a rated piv of 60 to 360 v. Applications include: converters, variable frequency generators, motor control, voltage regulation, replacement of magnetic amplifiers, and replacement of thyratrons. The device, similar to a thyatron, blocks voltage in the forward direction below a critical breakover voltage.

Westinghouse Electric Corp., Dept. ED, Box 2278, Pittsburgh, Pa.

**Price:** \$295 ea for quantities to 24 units.

## Wave Meter

679

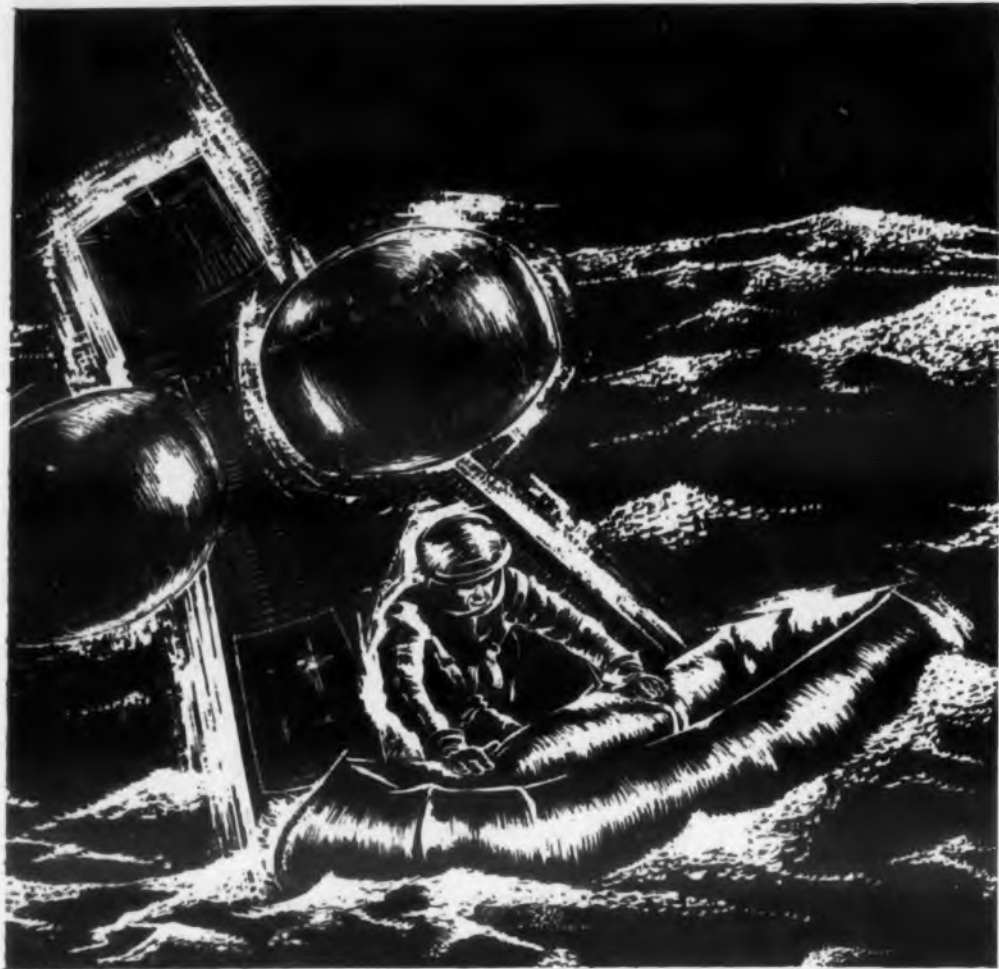
For the range of 1 to 2 kmc

Model 12-1 wave meter, for use as a marker cavity with a broad sweep generator, uses coaxial resonators and coaxial transmission line connections. Specifications are: range, 1 to 2 kmc; accuracy, 5%; nominal loaded Q, 1000; and absorption dip, 10% min. Resettability and readability are 0.025%.

Frequency Standards, Dept. ED, P.O. Box 504, Asbury Park, N.J.

CIRCLE 103 ON READER-SERVICE CARD





## space-age assignment: TOTAL RELIABILITY

The incredible complex of electronic instruments and equipment required to assure the safe return of early voyagers in space presents a great challenge to the electronics industry.

The Gudeman Company maintains a comprehensive components research and development program, dedicated to an ultimate goal of *total reliability*. The success of this and similar programs of progressive manufacturers throughout the nation can assure continuing progress for America's conquest of space.



*A new Gudeman Development!* The new Gudeman MR463 MEGA-REL capacitors (25% smaller than MIL-C-14157A & MIL-C-26244 (USAF) requirements, yet equivalent electrically and environmentally) reflect the creative engineering and constant design improvements that mark all Gudeman products.

## CAPACITORS BY GUDEMAN

THE GUDEMAN COMPANY  
MAIN OFFICE—340 W. Huron St., Chicago 10, Ill.  
MFG. BRANCHES: Terryville, Conn.; Visalia, Calif.

CIRCLE 104 ON READER-SERVICE CARD

## NEW PRODUCTS Silicon Rectifiers

488

Are rated at 18 and 35 amp



Types EA and DA silicon power rectifiers are rated at 18 and 35 amp, respectively. They are available with piv ratings of 50 to 600 v and have good inverse characteristics at all temperatures.

Vickers Inc., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

## Rotary Limit Switch

357

10 amp rating

The type 00-304 rotary limit switch is rated at 10 amp and weighs less than 0.16 lb. The lever can move continuously through 360 deg, and contains a micrometer screw adjustment. Internal cams are designed for specific applications. The unit is built around the firm's type 16 subminiature switch, with a mechanical life of over 20 million cycles.

Licon Div., Illinois Tool Works, Dept. ED, 3606 W. Dakin St., Chicago 34, Ill.

## Delay Lines

526

150 sections occupy 1 cu in.



Up to 150 of these lumped-constant delay-line sections can be contained in 1 cu in. of space. The units have delays of 0.1 to 20  $\mu$ sec, impedances of 100 to 2000 ohms, delay-to-rise time ratios of 100:1, and attenuations as low as 0.008 db. Uses are in missiles, data processing and computers.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

## Rapid, precise emf measurements with this L&N Type K-3 Universal Potentiometer



Emf's read as digits plus scale value

Fast, accurate d-c voltage measurements free of effects of static, humidity and leakage are made with L&N's Type K-3 Universal Potentiometer. In calibrating d-c wattmeters or voltmeters, checking thermocouples, etc., measurements are speeded as emf's are read directly as a single row of digits plus a scale value.

**Ranges**—High: 0 to 1.611 v. Medium: 0 to 0.1611 v. Low: 0 to 0.01611 v.

**Limits of Error**—Standardized and read on range in use: High range:  $\pm(0.01\% + 20 \mu\text{v})$ . Medium range:  $\pm(0.015\% + 2 \mu\text{v})$ . Low range:  $\pm(0.015\% + 0.5 \mu\text{v})$ .

**Internal Resistance**—Changes from about 180  $\Omega$  at full scale to about 110  $\Omega$  at zero setting.

**Galvanometer Sensitivity Keys**—Four tap keys provide sensitivities of approx. 1, 1/20, 1/400 and 1/10,000. Fifth key for reversal of connections.

**Standard Cell Dial**—1.0174 to 1.0205 v.

**Case**—Aluminum, 19 $\frac{1}{4}$ " long x 12 $\frac{1}{2}$ " wide x 5 $\frac{3}{4}$ " high to top of panel.

**Price**—\$730.00, f.o.b. Phila. or North Wales, Pa., (subject to change without notice). Specify List No. 7553 when ordering from Leeds & Northrup Company, 4908 Stenton Ave., Phila. 44, Pa.

**LEEDS**  **NORTHROP**  
Instruments Automatic Controls Furnaces

CIRCLE 105 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Display Unit

624



For analog-to-digital converters

The Digitester digital readout unit is designed to read the outputs of analog-to-digital converters using binary-coded decimal codes and having outputs in the form of open or closed contacts or suitable voltage level changes. Model 4A2 presents direct readout of 0.1-deg shaft angle converter from 000 to 359 deg; models able to display any number of digits can be furnished. Input is 115 v of 60 cps at 25 w; 400-cps operation is also available. Dimensions are 7 x 10 x 9 in. and weight of the unit is 10 lb.

Advance Industries, Inc., Dept. ED, 640 Memorial Drive, Cambridge 39, Mass.

**Price & Availability:** Model 4A2 is priced at \$745 job Cambridge. Delivery time is two weeks.

## Xenon Thyratrons

570

Rated at 1,700 v

This line of xenon thyratrons handles up to 1,700 peak forward and inverse voltages. They are rated at a 130 commutation factor. The use of xenon gas results in a tube drop of 11 v avg and stable control through an ambient temperature range of -55 to +75 C. Anode current ratings are 6.4 amp dc continuous, 12.8-amp dc 3-sec overload, and 80-amp oscillograph peak. The five tubes, designated EL C6H-1 through C6H-5, are made with five different basing and anode connections.

Electrons, Inc., Dept. ED, 127 Sussex Ave., Newark 3, N.J.

## Film Potentiometers

681

Low-noise type

These low-noise, precision, carbon-film potentiometers come in diameter sizes of 0.5 to 5 in. and in linearities to 0.015%. Less than 0.1% of the excitation voltage appears in the output as noise. Rotational speeds extend to 1,000 rpm. The units operate at video frequencies and meet Mil specs.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L.I., N.Y.

**Availability:** Delivery time is 30 to 45 days.

**5 WATT SERVO AMPLIFIER**  
-55°C to +125°C

2.2K  
51K  
56K  
2N327A  
2N1275  
2N1660  
1N537  
680 Ω  
270 Ω  
680 Ω  
20 VOLT ZENER DIODE  
-24 to -30 VOLTS  
OUTPUT  
POWER OUTPUT 5 WATTS INTO LOAD

This servo amplifier circuit exploits the high power gain capabilities of the 2N1660. The driver is a low power (250 mw) 2N1275 transistor. Ordinarily in such circuits the driver would need to be a medium power transistor or a high power unit such as the 2N389.

## New High Voltage, High Gain Transistors

# Make "Dream Circuits" Come True!

Full 2 amps, 25 megacycles, 85 watts . . . these are standard ratings for the 2N1660 power transistor family. Only Raytheon guarantees these values:  $H_{FE} = 45$  min. at  $I_C = 1$  ampere;  $h_{FE} = 4$  min. at 6 megacycles;  $F_t = 25$  megacycles min.

Put these new silicon power transistors to use for regulated power supplies . . . power switching . . . power amplifiers . . . power oscillators . . . core drivers . . . servo amplifiers — wherever reliable h.f. power handling is a problem.

Other Raytheon diffused silicon power transistors meet a wide variety of circuit requirements. Check the specifications in the accompanying table . . . see your Raytheon distributor for samples of production quantities.

The figures tell the story! These new NPN diffused silicon power transistors open up exciting possibilities for bold new circuit designs!



### Raytheon NPN Diffused Silicon Power Transistors

Temperature Range -65°C to +200°C.

Type	$V_{CE(sat)}$ Min. Volts	$V_{CE(sat)}$ Min. Volts	$V_{sat}$ Max. Volts	$f_{Hz}$ Min.	$V_{CE}$ Max. Volts	$F_t$ Min. Mc
Conditions: $R_1 = 33$ ohms						
			$I_C = 1A$	$V_C = 15V$	$V_C = 15V$	$V_C = 30V$
			$I_B = 0.2A$	$I_C = 1A$	$I_C = 1A$	$I_C = 100mA$
2N1660	80	10	4.0	45	3.0	25
2N1661	80	10	4.0	45	3.0	25
2N1662	100	10	4.0	45	3.0	25
2N1657	60*	3	3.0	15‡		
2N1470	60*	3	3.0	15‡		
2N389	60	10	5.0	12	8.0	
2N424	80	10	10.0	12	8.0	

\* $V_{CE(sat)}$

‡ $V_C = 5.0 V$ ;  $I_C = 1.0 A$



Available for immediate delivery from your local authorized Raytheon Distributors.

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CIRCLE 106 ON READER-SERVICE CARD





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Physical Plant

The dramatic growth of Vitramon, Incorporated during the past seven years reflects our industry's recognition of the critical importance of reliability in electronic components.

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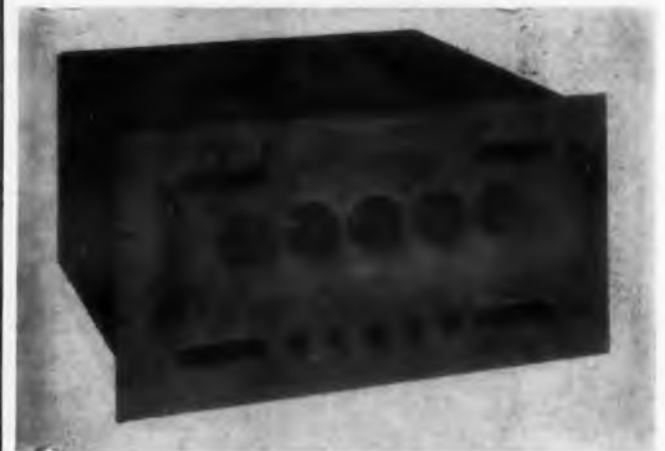
**VITRAMON**  
INCORPORATED  
BOX 544 • BRIDGEPORT 1, CONN.

## NEW PRODUCTS

### Constant Current Source

363

Currents from 10  $\mu$ a to 1 amp



Designed for meter calibration, transistor and diode forward testing, and as a filament current source, model CS-12 current governor furnishes currents from 10  $\mu$ a to 1 amp for load voltage from 0 to 7 v. The current is set to five places by decade knobs arranged to provide a digital in-line readout. Accuracies at any current setting are 0.5%  $\pm$  1  $\mu$ a. Line and load regulation are better than 0.01%. The unit is 19 x 10-1/2 x 18 in. and weighs 45 lb.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, L. I., N. Y.

Price & Availability: Price is \$995.

### Digital Logic Blocks

410

Have gold-plated contacts



The Digipac digital logic blocks include flip-flops, clocks, delays, inverters, gates, pulse amplifiers, and indicators. Circuits operate with wide margins at speeds to 1 mc. They are designed for use in permanent and semi-permanent controls systems. Power and logic connections are on opposite ends and either may be grounded without causing damage. The contacts are gold-plated. Average size is 1.5 cu in. with a weight of 1 oz and a dissipation rating of 50 mw.

Dynamic Controls Co., Dept. ED, 2225 Massachusetts Ave., Cambridge, Mass.

Price: Ranges from \$20 to \$39 ea.



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Electronic Supply  
909 Morningdale Dr.  
Parkway 3-1441

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24 Central Ave.  
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100 N. Western Ave.  
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140 11th St.  
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223 W. Madison St.  
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**PHOENIX**  
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ALPine 6-6121

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NAtional 2-8860

**SAN DIEGO**  
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3821 Park Blvd.  
CYprus 8-6181

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3408 E. Marginal Way  
MAln 3-6456

**DETROIT**  
Radio Specialties Co.  
456 Charlotte Ave.  
TEmplo 3-9800

**WASHINGTON, D. C.**  
Electronic Industrial Sales  
2345 Sherman Ave., N. W.  
HUSon 3-5200

**HOUSTON**  
Lenert Co.  
1420 Hutchins  
CApital 4-2863

**JAMAICA, N.Y.**  
Lafayette Radio  
165-08 Liberty Ave.  
AXtel 1-7000

**CANADA**  
Canadian Motorola  
Electronics Ltd.  
105 Bartley Drive  
Toronto 16, Ontario



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**ZENER APPLICATIONS HANDBOOK**  
Motorola's Zener Diode Handbook is a valuable reference book for circuit engineers. This 126-page guide to basic theory, design characteristics and applications is available through your Motorola Semiconductor distributor. Price \$1.



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*widest  
selection...*

*complete  
specs...*

*...HIGHEST  
reliability*

# MOTOROLA ZENER DIODES

**CHECK THE SPECS!** You'll find Motorola's comprehensive zener line-up offers an extra measure of reliability and design freedom.

**FIRST**, you have a wide selection. You're sure to find the precise device for your exact circuit requirements from Motorola's 1,952 different types.

**SECOND**, you get complete specifications. Units are measured at the 1/4 power level — the point of typical usage. Dynamic impedance is measured at two points and 100% scope-checked to give you a complete picture of the diode characteristics and to assure sharp knees. Temperatures are fully specified. Forward current ratings are specified and guaranteed.

**THIRD**, you get reliable operation. Motorola's diffusion process assures high reliability... excellent uniformity of char-

#### 1/4 WATT ZENERS

2.4 volt — 6.8 volt  
silicon units  
1/4 M2.4A2  
thru 1/4 M6.8A2  
6.8 volt  
to 200 volt  
diffused units  
1/4 M6.8Z  
thru 1/4 M200Z

#### 400 mW ZENERS

Diffused-junction  
units from  
6.8 to 200 volts  
1N957  
thru 1N992  
and 1N962B  
thru 1N952B\*

\*To meet the requirements  
of MIL-S-19500/117

#### 3/4 WATT ZENERS

Diffused-junction  
units from  
6.8 to 200 volts  
1/4 M6.8Z  
thru 1/4 M200Z

#### 1 WATT ZENERS

Diffused-junction  
units from  
6.8 to 200 volts  
1M6.8Z  
thru 1M200Z  
1N3016  
thru 1N3051  
and 1N3016B  
thru 1N3051B\*

\*To meet the requirements  
of MIL-S-19500/115

#### 1.5 WATT ZENERS

Diffused-junction  
units from  
6.8 to 200 volts  
1.5M6.8Z  
thru 1.5M200Z

#### 10 WATT ZENERS

Diffused-junction  
units from 6.8 to 200 volts  
10M6.8Z  
thru 10M200Z  
1N1351  
thru 1N1375  
1N1806  
thru 1N1815  
1N2970  
thru 1N3015  
and 1N2970B  
thru 1N3015B\*

\*To meet the requirements  
of MIL-S-19500/124A



#### 50 WATT ZENERS

Diffused-junction  
units from 6.8 to 200 volts  
50M6.8Z thru 50M200Z  
1N2804 thru 1N2846 and  
1N2804B thru 1N2846B\*

\*To meet the requirements  
of MIL-S-19500/114

#### 3/4 WATT REFERENCE DIODES

9.3 volt  
diffused-junction  
reference devices  
Temperature  
coefficients to  
.0005%/°C  
1N2620  
thru 1N2624

#### 1/2 WATT REFERENCE DIODES

9.0 and 11.7 volt  
diffused-junction  
reference devices  
Temperature  
coefficients to  
.0005%/°C  
1N935  
thru 1N939  
1N941  
thru 1N945

acteristics. Devices have very low temperature coefficients, extremely low dynamic impedance and a temperature range from -65°C to +175°C. All units are designed to meet or exceed the mechanical and environmental requirements of MIL-S-19500. Check Motorola for zener diodes to meet requirements of military specifications.

**THREE TOLERANCES — MATCHED PAIRS** Motorola offers standard tolerances of ±5%, ±10%, ±20%. Matched pairs available to 1%. Reverse polarity devices also available in 10 and 50 watt ratings.

For your next zener application, select the best — Motorola — available immediately at competitive prices from your Motorola Semiconductor distributor. Call him, today!

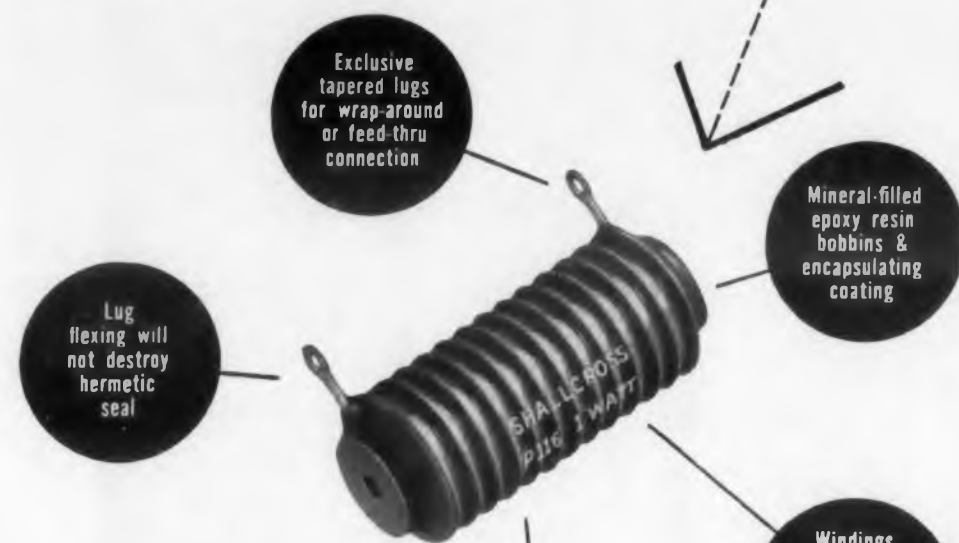
**FOR COMPLETE TECHNICAL INFORMATION** and applications assistance, contact your Motorola Semiconductor district office.



... Where only a Precision Wirewound  
is **Precise** Enough!

# Shallcross

"P" type RESISTORS



RADIAL LUG, AXIAL LEAD, and  
PRINTED CIRCUIT RESISTORS

**PRECISION RESISTOR NETWORKS** using specially stabilized resistors which may be matched to an accuracy of 0.005% with a tracking temperature coefficient of 5 ppm per °C—for use where voltage or current must be precisely controlled.



Unique  
contour  
provides long  
leakage  
paths

As specialists in precision wirewound resistors and resistor assemblies for over 30 years, Shallcross offers unmatched experience in meeting the most exacting matched resistor requirements. Encapsulated "P" Types illustrated are available in over 25 basic types—many to critical MIL-R-93A, MIL-R-93B, and MIL-R-9444 Specifications. Detailed performance comparisons to applicable MIL specs are available for all types.

SHALLCROSS MANUFACTURING CO., 4 Preston St., Selma, N. C.  
CIRCLE 110 ON READER-SERVICE CARD

## NEW PRODUCTS

### Shaft Encoder

356

Provides 1200 positions



Type C-139 shaft position encoder provides 1200 positions in a 320-deg revolution, binary-coded decimal code. Nominal readout speed is 60 rpm; maximum is 200 rpm. The unit uses a 3.5-in. disc and is housed in a case measuring 2 x 4 x 5 in. It stands  $\pm 8$  g at up to 1000 cps and 100 g steady along any axis.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave.,  
Monrovia, Calif.

Price & Availability: \$395 ea; from stock.

### Data Logger

698

For checking plant performance

Model PDL-1 process data logger provides data for evaluation of process performance in industrial plants. An analog-digital conversion system, the unit records signals received from transducers attached to the process functions. Linearization circuits, thermocouple reference junctions, zero suppression, and scale factoring networks are provided in the console. Power supplies are also self-contained within the unit. Data can be printed in three- or four-decimal digits.

Southwestern Industrial Electronics Co., Dept.  
ED, 10201 Westheimer Road, P.O. Box 22187,  
Houston 27, Tex.

### Voltage Regulator

701

Provides 24 to 32 v

Model 4-28 miniature, solid-state voltage regulator accepts unregulated direct voltages from 24 to 34 v and provides direct output voltages of 24, 26, 28, 30 and 32 v. Tested to stand severe environmental conditions, the unit provides regulated voltages to timing mechanisms, servo motors, and actuating mechanisms.

Acton Laboratories, Inc., Dept. ED, 533 Main  
St., Acton, Mass.

now available in  
a wide range of  
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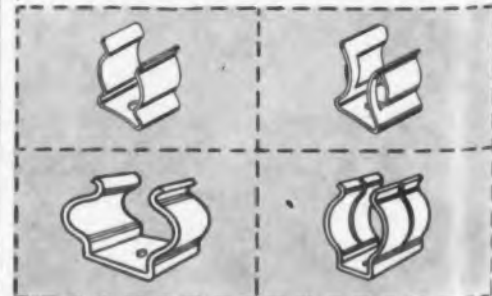
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**BRAUN TOOL & INSTRUMENT  
COMPANY, INC.**  
138 Fifth Ave., Hawthorne, N. J.



CIRCLE 111 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

## Printed-Circuit Connectors

489

Have tri-spring contacts



Series 093 printed-circuit connectors have triple, independent, leaf-spring-action contacts that grip the circuit board over the entire contact area. The connectors are designed for 3/32-in. boards. The contacts follow board displacement, preventing discontinuity caused by vibration. The units are offered in over 90 sizes and mounting styles.

Precision Connectors, Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

## Transistors

699

Come in pancake packages

For use in such equipment as airborne communications and computer systems, these pancake transistors have a height of 1/20 in. and a diameter of 1/4 in. The welded, vacuum-tight seal provides a leak-rating of better than  $10^{-9}$  cc per sec, without sealing materials. Designated types 1930, 1986, and 1987, these units are equal to types 2N357, 2N404, and 2N388, respectively, but with about a 10% reduction in size.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

Price: \$30 ea.

## Temperature Shock Chamber

708

For automatic cycling of components

This temperature shock chamber is designed for rapid, automatic cycling of electronic components and small assemblies undergoing environmental tests. Switching from hot to cold, in a range of  $-85$  to  $+425$  F, takes 10 sec, and recovery time to the set point takes 20 min. Entire operation is controlled with an automatic programmer. Measuring 5 x 7 x 8 ft, the unit's steel interior has a work space of 45 x 30 x 55 in. It will complete tests on as many as 25,000 transistors at one time.

Tenney Engineering, Inc., Dept. ED, 1090 Springfield Road, Union, N.J.

Availability: Delivery ranges upward from about 12 weeks after receipt of order.

Best  
solution  
to  
custom design  
potentiometer  
problems...



Merely write to The Gamewell Company, stating your requirements.

Gamewell engineers will take it from there. They've been designing high precision potentiometers and rotary switches for a good many years. And a great many of them have been custom-designed.

Naturally, this experience pays off. Take selection of the best resistance material for a given application as just one example. Here, Gamewell makes full use of all available alloys. And, backed by extensive files of in-service data, assures the best design of the resistance element in conjunction with the most compatible wiper-contact material.

When necessary, of course, Gamewell's complete development and test facilities are put to use. Salt spray, humidity, extreme temperature, altitude, acceleration, vibration and many more test facilities are available to insure exact matching of pot to requirements.

In production, Gamewell facilities give custom-designed "pots" and rotary switches the benefits of today's

most advanced methods and machines. Extensive metal working machinery, and refined dimensional checking devices assure production of every component to high precision tolerances. All "pots" are wound on precision machines, designed and built by Gamewell. And both winding and assembly are carried out in surroundings automatically kept spotlessly clean.

Thus it is that "pots" with even the most unusual electrical characteristics or mechanical features can be precisely produced in a minimum of time at Gamewell. Simplify your custom-designed potentiometer problems. Write THE GAMEWELL COMPANY, 1393 Chestnut St., Newton Upper Falls 64, Massachusetts. A Subsidiary of E.W. Bliss Company.



PRECISION POTENTIOMETERS

"INTEGRALS OF  
HIGH PERFORMANCE"

CIRCLE 112 ON READER-SERVICE CARD



## NEW PRODUCTS

### Alloy For Thermoelectric Use 402

Available in rods to 18 in. long



This bismuth telluride alloy is for use in the manufacture of thermoelectric modules for cooling volumes up to 4 cu ft. Both negative and positive types are available in the form of crystals up to 18 in. long. The figure of merit at 100 C for the positive type is  $4.45 \times 10^{-3}$  and for the negative type,  $2.7-3 \times 10^{-3}$ .

Materials Electronic Products Corp., Dept. ED, 990 Spruce St., Trenton, N. J.

*Availability: Both crystal rods and thermoelectric modules made from the rods are available for experimental use or for production purposes.*

### Double-Turret Solder Terminal 691

Mounts in a 0.094-in. hole

Type 1026 solder terminal has a double turret, mounts in a 0.094-in. hole, and is 0.237 in. high when mounted. Width of the terminal shoulder is 0.125 in. in diameter. Made of brass, the terminal is finished with 0.003-in. silver-plate plus water dip lacquer. It conforms to NAS 705.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

*Price & Availability: \$8.17 per 1,000 in quantities of 5,000; delivery from stock.*

### Ultrasonic Cleaner 687

Is self-contained

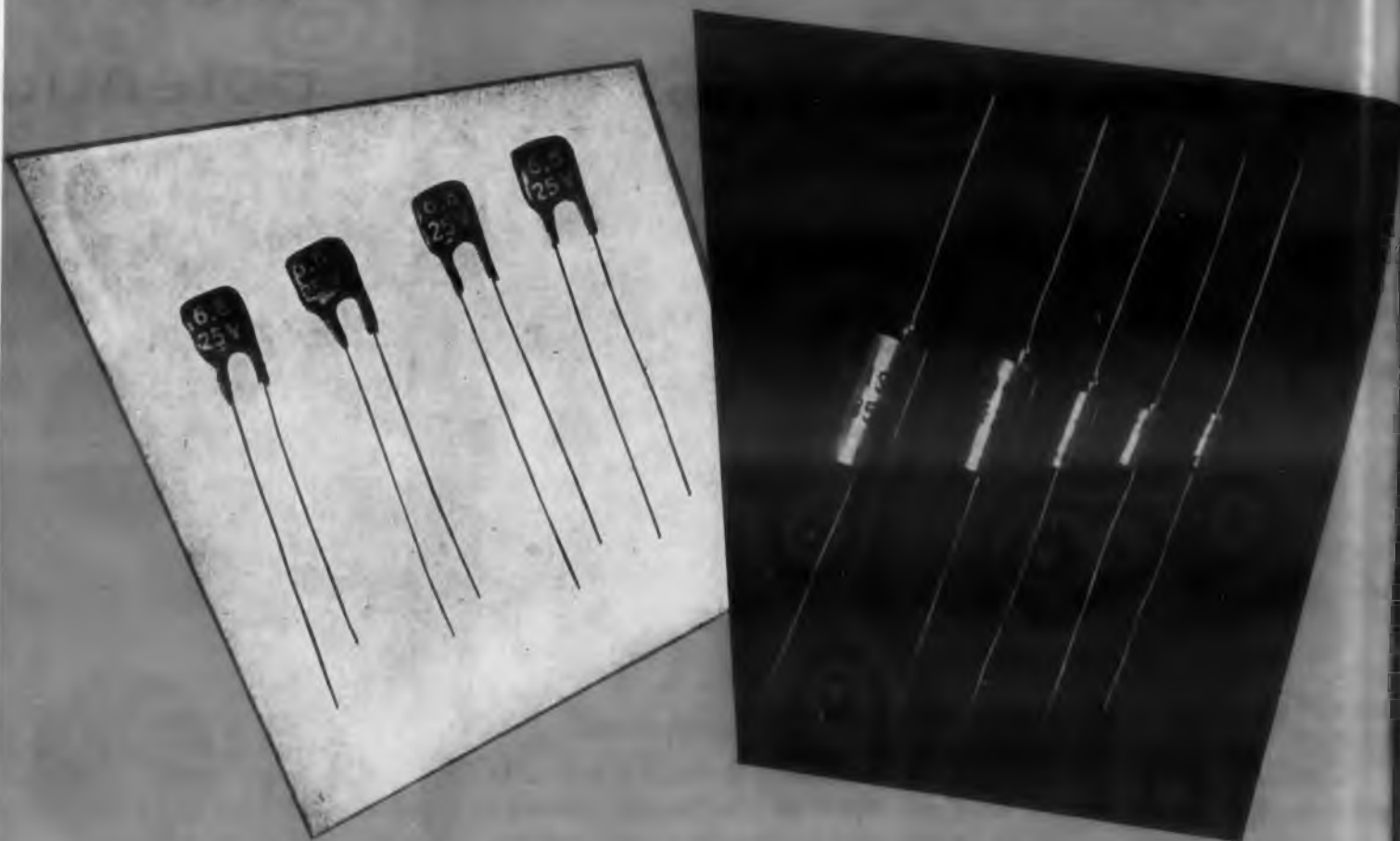
Model 320 ultrasonic cleaner is entirely self-contained, has an operating frequency of 70 to 80 kc, consumes 160 w, and has an output of 55 w. Two one-quart tanks are built into the generator body, enabling the circuit to transmit power directly from the generator to the transducerized tank. The second tank is for the rinse operation. Over-all dimensions are 14-3/4 x 9 x 10-1/2 in. Each tank measures 5-1/2 x 5-1/2 x 3 in.

L & R Manufacturing Co., Dept. ED, 577 Elm St., Kearny, N.J.

*Price: \$187.50, including cleaning solution concentrate.*

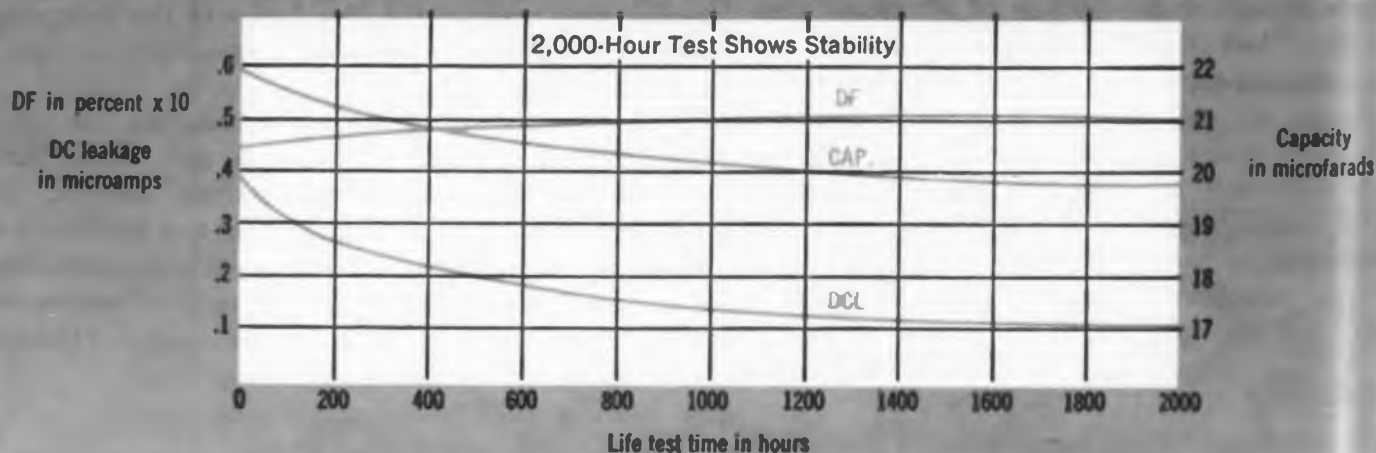
See Mallory For

# SOLID TANTALUM



## MALLORY SOLID ELECTROLYTE TANTALUM CAPACITORS

Type	Capacity Range	WVDC Rating	Temperature Range	Case Style	Case Size Range
TAM	4.7-56 mfd.	25-6V	-55 to +85°C	Plastic encapsulated, upright mounting	.188" thick, .313" square
TAS	.33-330 mfd.	35-6V	-80 to +85°C	Metal case axial leads	.125" diam. x .250" length to .341" diam. x .750" length



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ELECTR

# CAPACITORS

... widest selection

... highest reliability

When you're designing transistorized miniature equipment, you'll find that Mallory solid tantalum capacitors offer new design opportunities because of their stability, freedom from electrolyte leakage, broad temperature range, and high capacitance/volume ratio. Leader in tantalum capacitor development, Mallory gives you extra value in solid types:

**Widest selection** in the industry. Metal-case subminiature Type TAS, in ratings from .33 to 330 mfd., 35 to 6 volts . . . and the unique, encapsulated Type TAM, especially useful in printed circuits because of its square-case, self-insulated design with grid-spaced parallel leads.

**Exceptionally low leakage current** . . . key to reliability and high temperature capability . . . obtained by special Mallory processing.

**Long Life** . . . proved by tests to 10,000 hours.

**Broad temperature range** . . . rated for 85°C; operable at 125°C at 2/3 rated voltage, and currently being evaluated for even higher temperatures. Low temperature rating: -55°C for TAM, -80°C for TAS.

Write or call us for a consultation on your solid tantalum capacitor applications. See us, too, for all your tantalum capacitor requirements. Our line of 16 different types is the broadest available . . . covers solid, sintered anode, and foil types, from microminiature to high capacity.

Immediate delivery on 16 Mallory Tantalum Types

HAT: microminiature, metal case	TAP-3: miniature, 30-325 mfd.
TAS: miniature, solid type	M2: miniature, 150°C
TAM: miniature, solid type, plastic encapsulated	XTK: miniature, 175°C
TAF: foil type	XTM: miniature, 175°C
STNT: subminiature, metal case	XTL: miniature, 200°C
TNT: miniature, metal case	XTH: 200°C
TAP-1: miniature, 2-30 mfd.	XTO: 200°C
TAP-2: miniature, 11-140 mfd.	XTV: high capacity, 175°C

Mallory Capacitor Co. • Indianapolis 6, Indiana  
a division of

P. R. MALLORY & CO. Inc.  
**MALLORY**

Mallory Capacitor Company for a complete line of aluminum and tantalum electrolytic capacitors, and motor start and run capacitors.



CIRCLE 113 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960



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Engineering Supply Co.  
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White Plains, N.Y.  
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Winston-Salem, N.C.  
Dalton-Hege Radio Supply

## Planetary Ball Drive Unit

503

Has 6 to 1 ratio



This planetary ball drive unit, model 4511/DAF, has a ratio of 6 to 1. Four models are available and they have epicyclic friction drives. Dimensions are: diameter, 3/16 in.; length, 22/32 in. plus 1-1/8 in. shaft; shaft diameter, 1/4 in. The units are made in England by Jackson Bros.

M. Swedgal Electronics, Dept. ED, 258 Broadway, New York 7, N.Y.

Price: \$1.50 per unit.

## Microwave Relay System

674

Covers 10.7 to 13.2 kmc

Model KRT 1000H microwave relay covers frequencies from 10.7 to 13.2 kmc. Transmitter output power is 0.1 w. The klystron tubes in the unit will operate for 7,500 hr. Conversion kits, including klystron and plumbing assembly of WR-75 waveguide, are also available.

Raytheon Co., Dept. ED, Waltham 54, Mass.

## RF Amplifier

490



Range is 225 to 400 mc

Model RD-210 1-kw rf amplifier, designed for final stage uhf transmitter use, is continuously tunable from 225 to 400 mc with a carrier operating in F-1 or A-3 mode. A class B linear unit, the amplifier provides complete monitoring of all pertinent supply voltages and currents along the forward and reflected output power. Provisions for metering vswr and for frequency alignment are included. The power supplies utilize silicon diodes.

Manson Laboratories, Inc., Dept. ED, P. O. Box 1214, Stamford, Conn.

117



# Coax Switch Successful 8,000,000 miles from Earth



Pioneer V's successful switchover from the 5 watt transmitter to the 150 watt telemetry system by a Transco "Y" Type Coaxial Switch marks a milestone in accurate and reliable switching.

PROOF POSITIVE that this and other Transco switches can always be relied upon for positive operation — even in the most severe environmental conditions. Be sure to have complete specifications on hand for your next project.

IMPEDANCE 50 ohms  
FREQUENCY to 11 KMC  
VSWR 1.25 at 5 KMC  
INSERTION LOSS .15 db at 5 KMC  
CROSSTALK 35 db at 5 KMC  
WEIGHT 6 oz.

When you have a microwave switch problem be certain you contact Transco — BECAUSE Transco is the world's largest manufacturer of microwave switches — designing and building more types of switches than any other firm.



PIONEER V PROJECT IS CARRIED OUT BY SPACE TECHNOLOGY LABORATORIES FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION UNDER THE DIRECTION OF THE AIR FORCE BALLISTIC MISSILE DIVISION.

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COAXIAL SWITCHES  
WAVEGUIDE SWITCHES  
ANTENNAS  
MICROWAVE COMPONENTS  
VALVES  
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CIRCLE 114 ON READER-SERVICE CARD

## NEW PRODUCTS

### Beam Pentode 513

Will deliver 400 w usable power



Type 4E27A beam pentode, suitable for use as an amplifier, modulator, or oscillator, will deliver over 400 w usable output at 2 w driving power in class C service. As a class  $AB_1$  linear amplifier, it provides 260 w of usable power. Plate dissipation rating is 125 w. Maximum plate voltage is 4,000 v and maximum plate current is 200 ma. Grid-screen mu-factor is 5 and transconductance is 2,500  $\mu$ mhos.

Penta Laboratories, Inc., Dept. ED, 312 N. Nopal St., Santa Barbara, Calif.

Price & Availability: \$30 to \$40 ea; from stock.

### Electronic Counter 521

For measurements of 1 cps to 20 kc



Model 1301P portable electronic counter is designed for measurements in the range of 1 cps to 20 kc. It contains four multivibrator-type display units. Associated with these are input and gating amplifiers and a 1-sec gate generator.

Aerotron Associates, Inc., Dept. ED, Contoocook, N.H.

Price: \$3.75 ea fob Contoocook.

### Frequency Standards 522

For aircraft and missile use



The Chronodyne frequency standards, designed for aircraft and missile use, meet frequency requirements from 250 to 2,500 cps. They stand 5 g peak vibration and 50 g shock for 11 msec. They are available with accuracy ratings of either  $\pm 0.025\%$  or  $\pm 0.05\%$  over the ambient temperature range of  $-40$  to  $+80$  C. The units weigh 2 oz and measure  $5/8 \times 1.5 \times 1.5$  in.

Armec Corp., Dept. ED, 195 W. Hills Road, Huntington Sta., L.I., N.Y.

### Silicon Power Rectifiers 529

Piv is 100 to 400 v



These silicon power rectifiers, composed of styles ES-21 and ET-21, have piv ratings of 100 to 400 in 100-v steps. The peak forward voltage is 1.5 v max in 25 amp and the peak inverse current is 5 ma at 100 C. Thermal drop is 2.75 C per w. Mounting torque is 50 lb-in. for the ES-21 and 300 lb-in. for the ET-21.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.

Price & Availability: \$2.56 to \$4.16 ea; 14-day delivery time.

## Crystal Filter Transformer

509

Range is 50 kc to 50 mc

Having a frequency range of 50 kc to 50 mc, the type 2000 series miniature, hybrid transformer is designed for use in crystal filters. The units are epoxy-cased with printed circuit construction. Operating temperature range is from  $-55$  to  $+125$  C with a temperature coefficient as low as 40 ppm per C. Claims for the unit include tight coupling, controlled "L" ratios, and high Q.

Allen Avionics, Inc., Dept. ED,  
255 E. 2nd St., Mineola, N. Y.

## Barium Ferrite Magnets

380

Produce  $3 \times 10^6$  gauss-oersteds

Type F-500 oriented barium-ferrite, permanent magnets produce more than  $3 \times 10^6$  gauss-oersteds with a remanence of 3900 gauss and a coercivity of 1900 oersteds. Rings, discs, and blocks are offered in thicknesses of 0.3 to 1 in. and up to 50 sq in. in area. They may be supplied magnetized or not magnetized.

D. M. Stewart Manufacturing Co., Dept. ED, 3660 Jerome Ave., Chattanooga, Tenn.

*Availability: The product is made on order and has a delivery time of 45 to 60 days.*

## Mixer-Preamplifier Unit

559

If center frequency is 30 or 60 mc

Model MMC-2 integrated waveguide mixer-preamplifier is for use over the rf spectrum of 5.15 to 5.85 kmc. If center frequencies of 30 or 60 mc are standard. Minimum gain is 25 db and over-all noise figure is less than 7.5 db. Over-all mounting space needed is greater than that required for the mixer unit alone.

Lel, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

*Price & Availability: \$1490 ea; \$1095 ea in quantities of 10 to 24 units. Delivery time is 60 days.*

# Lockheed's Record of Achievement

## -in Electronics

**N**ew and expanding air/space programs at Lockheed point to the importance of electronics—from research and development to complete systems. Program diversification extends from space and atmospheric vehicle systems and components to studies to develop new techniques for neutralizing the submarine menace.

Some of the critical areas under investigation in electronics include: Design and development of electronic ground support test equipment; development of antenna equipment to receive telemetered, tracking and relay data in support of current and future sophisticated missiles and space projects; research, design and development of advanced antennas such as steerable UHF, electronic countermeasures, radomes, retarded wave; electromagnetic research in corona and high altitude breakdown studies, surface wave generation, antenna vehicle interaction, millimeter wave radiometry.

Areas of investigation in other fields include: Solid state physics studies in improved radiation sensors and new solid state electronic devices; physics—photoconductivity and optics, solar, infrared; underwater sound propagation and oceanography studies; the flight sciences; autocontrols and servosystems.

Lockheed's record of achievement is being extended to many new fields. Shown here are examples of programs that range from research to final development and production:

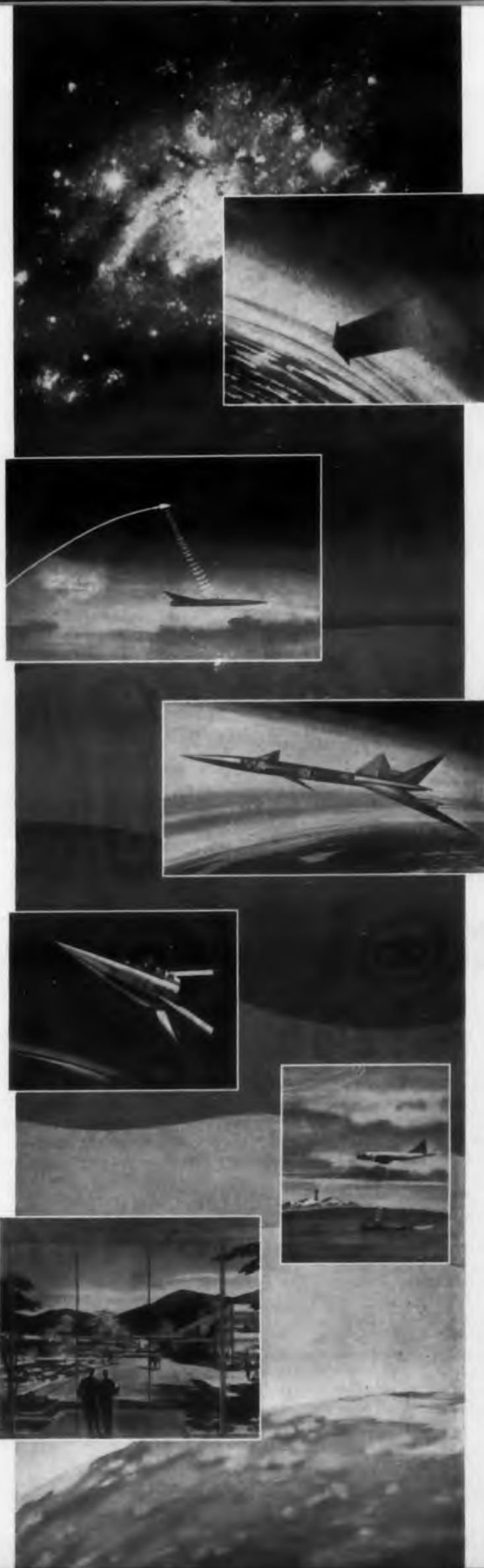
- Orbital Reentry Studies
- Infrared Systems Studies
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**SCIENTISTS AND ENGINEERS** of outstanding ability are invited to investigate opportunities offered by a company that always looks far into the future. Openings are available in: Electronics systems; automatic controls; servosystems; antenna research; electronics research; physics—photoconductivity, solar, infrared; flight test instrumentation; service engineering.

Please address your inquiry to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1308, 2407 No. Hollywood Way, Burbank, California.

# LOCKHEED

CALIFORNIA DIVISION







## Breakers to order

### Wideband Amplifier 525

For low-level signals



Type 1121 low-noise, two-stage, cascode-input amplifier is designed to increase the amplitude of low-level, wide-band signals and suits applications requiring up to 100 in voltage gain. The terminated output allows at least 100 ft separation between the amplifier and the associated instrument. The  $\pm 1$ -v output provides linear amplification of any input up to  $\pm 10$  mv at full gain. Rise time is about 21 nsec. Bandwidth is 5 cps to 17 mc.

Tektronix, Inc., Dept. ED, P. O. Box 831, Portland 7, Ore.

Price: \$425.

### Tape Transport Systems 505

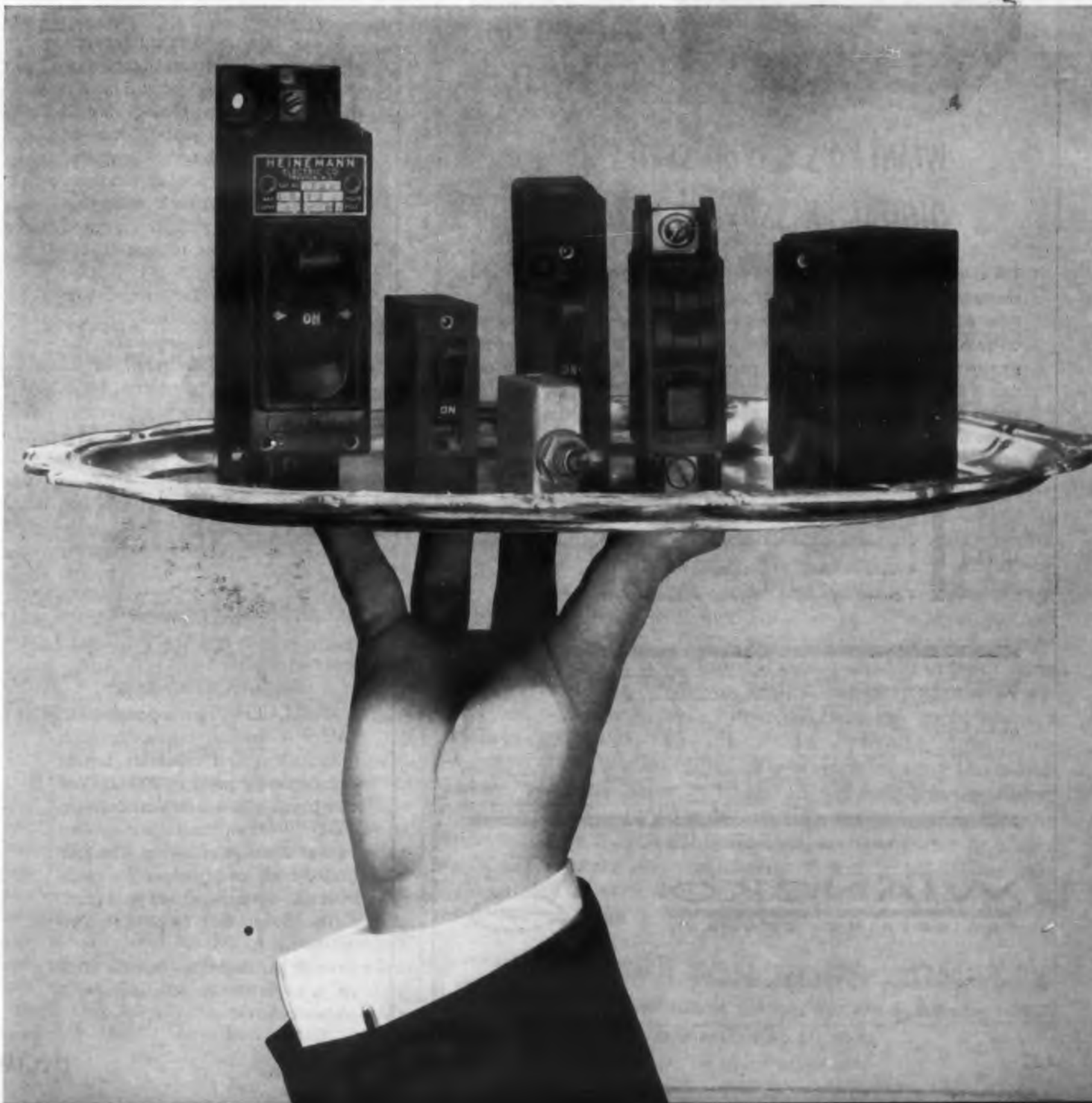
For digital data on magnetic tape

Digital tape transport model M300 is designed to accelerate the handling and storage of data on magnetic tape. It uses a linear-action, electropneumatic reeling and tape drive system that provides gentle, positive tape handling. Avoiding the use of reciprocating parts and components, the transport uses solid-state circuitry. The read and write heads are of all-metal construction, providing inherent protection from clogging and oxide adherence. The unit is free of all programming restriction up to its highest tape speed.

Midwestern Instruments, Dept. ED, 41st & Sheridan Road, Tulsa 18, Okla.

Price & Availability: Made on order only; prices range between \$10,000 and \$20,000 for various types.

Who else but Heinemann can give you circuit breakers, single-pole or multi-pole, in any integral or fractional current rating you need (from 0.010 to 200 amps) . . . with a choice of several time-delay ranges (or instantaneous-trip action)? Who else can offer you these advantages in a line of breakers from subminiature size on up? Who else, as a matter of fact, can guarantee the kind of temperature-stable, derating-free performance that only hydraulic-magnetic actuation provides? It might just be that we can make you a breaker precisely suited to that tricky job you're working on. Our Circuit Breaker Engineering Guide, Bulletin 201, will give you specs and stuff, and may suggest some possibilities. *Heinemann Electric Company, 156 Plum Street, Trenton 2, New Jersey.*





# BREAKTHROUGH IN THE SCIENCE OF PRESSURE CONTROL



*digital-servo  
reliability  
crystal-determined  
accuracy*

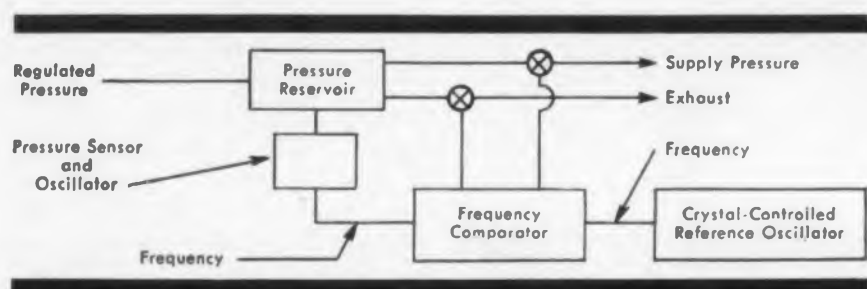
## WIANCKO'S Q3700 SERIES DIGITAL PRESSURE GENERATOR

This system, employing unique digital-servo concepts, provides instant selection of a pneumatic pressure accurate to  $\pm 0.05$  PERCENT.

Pressure in a reservoir is measured and converted to a precision frequency. This frequency is compared with a selected reference frequency. If the frequency from the pressure sensor is high with respect to the reference frequency, the comparator produces a difference frequency in the form of pulses. These pulses then drive momentary exhaust valves until the pressure drops to the pre-selected value. When the frequency is low, error signals are produced which operate momentary pressurizing valves. The Q3700 is the best answer yet to pressure control and calibration problems.

Ideal for:

- Programming precision pressure/time functions
- Automatic end-to-end calibration of data and telemetering systems
- Rapid calibration of pressure devices
- Ground checkout of instrument and control systems



For complete information please request Product Bulletin 111

**WIANCKO**  
ENGINEERING COMPANY



*Precision with lasting reliability*

255 North Halstead Avenue • Pasadena, California

## NEW PRODUCTS

### Computer-Type Switches 517

Are dpdt type



These illuminated computer-type switches can be either maintained or momentary contact type and have a dpdt arrangement. Ratings are 3 amp at 250 v, 5 amp at 125 v ac or dc, and as low as 5 mv, 25 amp and less for dry circuit applications. Complete with panel indicating lights, this line of units can be used in data systems and in ground support equipment.

Cutler-Hammer Inc., Dept. ED, 538 N. 12th St., Milwaukee, Wis.  
**Availability:** Made on order, the switches can be delivered in 42 days.

### Lead Holder 516

For continuous use at 200 C



Model CLH-104 component lead holder is for use in development, qualification, and reliability testing of component parts at 200 C. Contact pressure is maintained between 5 and 7 lb at maximum jaw opening by a stainless steel spring. The connector body and plunger are made of brass with a nickel and gold plate.

The Davep Co., Dept. ED, Livingston, N.J.  
**Price & Availability:** Price is \$0.90 ea in quantities to 100; delivery is from stock.

### Power Supply 555

Provides 28 v at 50 amp

Type M-1217A power supply has a dc output of 28 v  $\pm 10\%$  at 50 amp. Line and load regulation at nominal output is  $\pm 5\%$ . Regulation is  $\pm 5\%$  for line and load changes from no load to full load. Ripple is 2% rms. Input required is 440 v, 60 cps, three phase.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

**Price & Availability:** \$1520 ea; 90-day delivery time.

### Potentiometer Switches 558

With 0.5 and 2-w potentiometers

Providing both volume control and push-pull switching, these potentiometer switches are offered in a complete range of resistance values. The series 43 2-w wirewound potentiometer and the series 47 0.5-w composition potentiometer are used. Uses are in radios, TV receivers, and intercommunications equipment.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

**Price & Availability:** List price is \$57.10 ea; delivery is from stock.

### Miniature Relay 557

Contacts are rated at 2 amp

Type SM relay has a hermetically sealed contact chamber to isolate the contacts from contamination. A CVE armature, pivoted on jewels, enables the relay to stand shock of 50 g and vibration of 30 g at up to 2,000 cps. The contacts are 2 pdt rated at 2 amp at 30 v dc with a resistance of 0.05 ohms max; contact life is 100,000 operations. The relay weighs 18  $\pm 1$  g and measures 0.875 x 0.8 x 0.4 in.

Couch Ordnance, Inc., Dept. ED, 3 Arlington St., North Quincy 71, Mass.

**Price & Availability:** \$16 ea in small quantities; one-month delivery.

# NEW FLANGELESS SILICON RECTIFIERS

from **MOTOROLA**

Now you have your  
choice of three silicon  
rectifier packages  
from Motorola.

The new flangeless units are smaller than top hats yet offer identical ratings. They lay flat like a resistor for easy connection to terminals. Both the Motorola flangeless and top hats are tested at 150% of PIV to assure you extra reliability.

Whether you require top hats, studs, or the new flangeless, look to Motorola for your silicon rectifier requirements. JAN types also available. For complete technical information contact your Motorola Semiconductor district office.

TOP HAT RECTIFIERS		FLANGELESS RECTIFIERS	
Type No.	PIV	Type No.	PIV
1N537	100	1N2610	100
1N538	200	1N2611	200
1N539	300	1N2612	300
1N540	400	1N2613	400
1N1095	500	1N2614	500
1N547 & 1N1096	600	1N2615	600

STUD MOUNTED RECTIFIERS			
Type No.	PIV	Type No.	PIV
1N253	100	1N1116	200
1N254	200	1N1117	300
1N255	400	1N1118	400
1N256	600	1N1119	500
1N1115	100	1N1120	600

JANS			
STUDS		TOP HATS	
Type No.	PIV	Type No.	PIV
JAN 1N253	100	JAN 1N538	200
JAN 1N254	200	JAN 1N540	400
JAN 1N255	400	JAN 1N547	600
JAN 1N256	600		



**MOTOROLA**  
Semiconductor Products Inc.

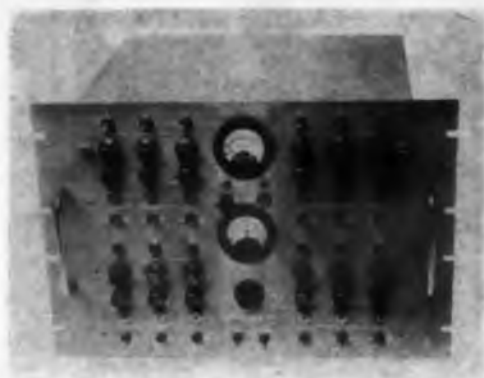
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 NEW YORK 1051 Beantfield Ave., Clifton, N.J. Gregory 2-3200  
 NEW YORK 1051 Beantfield Ave., Clifton, N.J. Wisconsin 7-2888  
 NEW YORK 1051 Beantfield Ave., Clifton, N.J. Midway 7-2307  
 NEW YORK 1051 Beantfield Ave., Clifton, N.J. Titus 7-7029  
 PHOENIX 130 South Eastern Rd., Glendale, Pa. Diamond 2-3228  
 SAN FRANCISCO 1299 Bayshore Highway, Burlingame, Calif. Olympic 4-3251  
 ST. LOUIS 101 South Solina. Olympic 4-3251  
 WASHINGTON 8855 Cameron St., Silver Spring, Md. Olympic 5-4485

## Input Conditioning Unit

360

Has 12 channels



This 12-channel strain gage and transducer input conditioning unit is for feeding oscillographs directly or front ends of data acquisition systems. Designated model 12-200BX, the unit accommodates 12 resistance-type transducers, 1, 2, or 4 active arms, employing 3, 4, 5, or 6 wire input techniques. Sensitivity losses due to cable length are calibrated out.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

Price & Availability: \$1828 ea; 45-day delivery time.

## Temperature Chamber

690

For missile-aircraft components

Model TE-100 temperature chamber is for missile-aircraft component tests requiring high-low temperature environments and vibration in all three axes. The chamber is designed to be used with the TC-109 temperature conditioning unit which provides high flow of high- or low-temperature air. A hydraulic lift, making the chamber self-elevating for use over vibration exciters or oil-film vibration slip tables, is optional.

Wyle Manufacturing Corp., Dept. ED, El Segundo, Calif.

Availability: Delivery time is three weeks.

## Transistors

676

Drift-field type

These pnp, germanium, drift-field transistors come in compact, three-lead cases. Types 2N1524 through 2N1527, 2N1631 through 2N1636 are for battery-operated am broadcast-band, portable radios. Types 2N1637 through 2N1639 are for am broadcast-band auto radios. Units with three leads for printed or wire-in type circuit applications conform to the TO-1 JEDEC package. Units with three pins for plug-in or socketed type applications conform to TO-40.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.



PRECISION-FORMED  
ENCAPSULATING  
SHELLS AND HEADERS



NEW TECHNIQUE FOR  
VOLUME PRODUCTION OF  
PACKAGED COMPONENTS  
AND CIRCUIT MODULES

No molds to make and maintain! With shell-and-header encapsulation, the mold is the package. You just mount the component on the header and press-fit the header in the shell. The encapsulant fill, you put in any way you like: pellet, powder, poured or pressure-fed liquid. □ The package you'll get will be flawlessly smooth surfaced, precisely dimensioned, perfectly uniform from batch to batch. It will cost you less to produce. And it will be a whole lot neater and more attractive than any mold casting. □ Where can you get more information? From the Milton Ross Company. We manufacture all sorts of encapsulating shells and headers. We make them in colors, for color coding. In diallyl phthalate, alkyd or other high-temperature plastics. In standard pin-circle or tenth-inch configurations, or in any size or shape the customer wants (at no tooling cost to him, on volume orders). We'd be glad to work with you on any ideas you might have in mind. Give us a call or drop us a note.



**THE MILTON ROSS COMPANY**

236 Jacksonville Road, Hatboro, Pa. Phone: OSborne 2-0551

S.A. 2292



## The Leaders Specify ALPHLEX® TUBING & SLEEVING

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TYPE	DESCRIPTION	GRADE	DIELECTRIC STRENGTH V/MIL	TEMP. RATING	LOW TEMP. FLEX.	OIL RESISTANCE	SIZES & COLORS
PVC-105 PLASTIC TUBING	High resistance to heat, oil, chemicals, corrosion, fungi; no loss in tensile strength or flexibility. Protects irregular objects and snakes well.		800	105°C	-30°C	remains flexible indefinitely	#24-#12 A-I #11-#2 A, B, C, D, G, H #2½-#1 A, B
PVC-744 PLAST. TUBING	Specifically designed for sub-zero temperatures.		550	70°C	-67°C	Good	#24-#0 A
PIF-130 PLASTIC IMPREGNATED FIBERGLASS SLEEVING	Class B insulation for continuous operation to 130°C. Excellent color retention even on prolonged baking at high altitudes.	A-1 B-1 C-1	8000 4500 2500	130°C 130°C 130°C	-30°C -30°C -30°C	Good Good Good	#24-#2 B, C, D, E #1 and larger C, D
VTS-135 VARNISH IMPREGNATED TUBING & SLEEVING	Class B insulation for general use; high tensile strength, good flexibility, non-peeling cracking, low moisture absorption, acid oil resistant.	A-1 B-1 C-1	7000 4000 2500	135°C 135°C 135°C		Good Good Good	#24-#2 B, C, D, G #2½-#1 B, C
TFT-800 TEFLON EXTRUDED TUBING	Unmatched for electrical application at high temperature frequencies. Thin, flexible, permits miniaturization and compactness.		500-1000	250°C	-90°C	Excellent	#30-#15 B-K #14-#8 B, C, D, F, G, H, I, J #7-#0 J
SRF-250 SILICONE RUBBER EXTRUDED TUBING	Excellent tensile strength, elongation, and tear strength, low water absorption and good oil resistance.		400	200°C	-85°C	Good	#28-#10 H
PVC-80 EXTRUDED PLASTIC TUBING	Excellent snaking, expands to irregular shapes. Dilates under certain conditions and resumes its size if it is the polyvinylchloride type.		800	80°C	-30°C	stiffens slightly	#24-#12 A-I #11-#2 A, B, C, D, G, H #2½-#1 A, B
PLE-70	(Same as PVC-80)		1200	80°C	-70°C	swells slightly	#24-#7 J
SRF-200 SILICONE RUBBER FIBERGLASS TUBING	Class H insulation, excellent for shock resistance, extreme flexibility and freedom from cracking and crazing at extreme temperatures.	A-1 B-1 C-1	7000 4000 2500	200°C 200°C 200°C	-67°C -67°C -67°C	Good Good Good	#24-#15 B-K #14-#2 B, C, D, G, H, J #1-#½ B, C, H, J
HTF-1200 HI-TEMPERATURE FIBERGLASS SLEEVING	Class H insulation. Tightly braided sleeving for use up to 650°C. Can be colored for coding. Special constructions up to 1/16" wall thickness and double wall thickness available.		Determined by space factor	650°C	-55°C	Good	#24-#½ B, J
SFS-400 SILICONE IMPREGNATED FIBERGLASS TUBING	Class H insulation for high temperature use. Remains flexible and retains its electrical properties to 205°C.	C-1 C-2 C-3	2500 1500 Space factor	205°C 205°C 205°C	-39°C -39°C -39°C	Good Good Good	#24-#½ J

A. CLEAR B. BLACK C. YELLOW D. RED E. BLUE F. BROWN G. GREEN H. WHITE I. ORANGE J. NATURAL K. VIOLET

**ALPHA WIRE CORPORATION** Subsidiary of LORAL Electronics Corporation  
200 Varick Street, New York 14, N. Y.  
Pacific Division: 1871 So. Orange Dr., Los Angeles 19, Calif.

CIRCLE 121 ON READER-SERVICE CARD

## PRODUCTION PRODUCTS

### Vacuum Pump

260

Achieves below 10<sup>-9</sup> mm Hg



The UlteVac 327 Pump achieves a vacuum below 10<sup>-9</sup> mm Hg with a cold-cathode discharge in a magnetic field. It removes gas molecules and atoms from circulation by formation of chemically stable compounds and ion burial. The pump, invulnerable to power failure, draws current in relationship with pressure, permitting it to act as a vacuum gauge. Applications of the pump include vacuum-tube and semiconductor-processing, thin films and particle accelerators.

Ultek Corp., Dept. ED, 920 Commercial St., Palo Alto, Calif.

### Ultrasonic Generator

261

Output is 1 kw



Model G-310 Ultrasonic Generator is rated at an output of 1 kw average power and 2 kw of peak power at 38 to 42 kc; it will drive a barium-titanate crystal with a radiating surface of 192 sq in. The generator is designed for production line cleaning and degreasing, pilot plant testing of large-scale cleaning operations or adding ultrasonics to conventional equipment. The unit, which operates on 115 v at 20 amp, measures 21-3/4 x 18 x 28-5/8 in. and is powered by two vacuum tubes. It weighs 225 lb.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N.J.

Price & Availability: The generator is priced at \$1,375 and is available in 2 to 3 weeks.

ELECTRONIC DESIGN • August 17, 1960



## TERAGLAS

A NEW CLASS B INSULATION WITH RESILIENT WEAVE AND HIGH DIELECTRIC STRENGTH UNDER STRETCH

Natvar Teraglas is a new flexible insulating material comprising a base fabric, woven from polyester (polyethylene terephthalate, or "Dacron") warp yarns and continuous filament glass filler yarns, coated with an improved varnish, possessing exceptional dielectric strength under elongation. It will withstand Class B (130°C) operating temperatures.

In view of the higher dielectric strength of Natvar Teraglas compared to bias varnished cambric, thinner sections or fewer layers may be used to provide the voltage breakdown protection desired. Consequently, at comparable tape prices, a significant saving may be realized in production costs, while permitting up-grading to Class B (130°C) temperatures.

Natvar Teraglas will prove advantageous in many applications—for insulating motors, generators, transformers, cables, switch gear, busbars, and other apparatus and equipment where resiliency and high dielectric strength are desirable.

Natvar Teraglas is available in two thicknesses, .010" and .012"—in tapes, in full width rolls (36"), or in sheets. Ask for Data Sheet and Samples.

\*Trademark applied for.

**NATVAR CORPORATION**

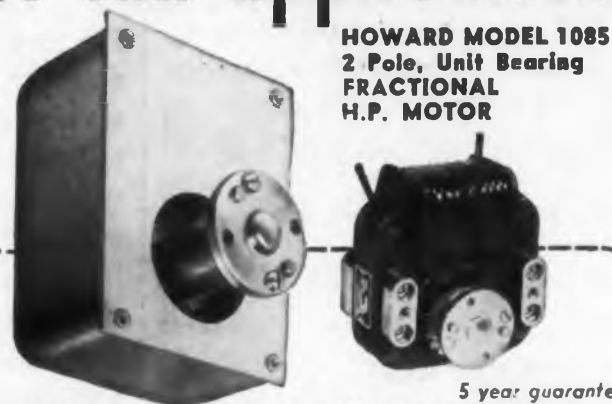
FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION  
Telephone: FULTON 8-8888 Cable Address: NATVAR: RANWAY, N. J.

241 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

CIRCLE 122 ON READER-SERVICE CARD

THE CHOICE OF LEADING MANUFACTURERS

## for fan applications



HOWARD MODEL 1085  
2 Pole, Unit Bearing  
FRACTIONAL  
H.P. MOTOR

5 year guarantee

Available with Open or Closed Construction

MOUNTING: From rear or by special pads on front.

BEARING: Single, long-life, permanently lubricated.

STATOR: Vacuum varnish impregnated coil on molded nylon bobbin.

ROTOR: Dynamically balanced for ultra-quiet operation.

ROTATION: Unidirectional (CW or CCW as specified).

SHAFT-HUB: Assures positive and accurate location of connecting part (fan) which must run concentric. Can also be furnished with shaft extension from hub.

Send us your specifications or write for complete catalog.

HP: 1/750 to 1/105

NO LOAD RPM: 3400

FULL LOAD RPM: 2600-3200

INPUT WATTS: 8-30

VOLTS: 115 V. 60 cy. AC std.

\*Lower full load speeds also available.

POWERED BY  
**HOWARD**

HOWARD INDUSTRIES, INC.

1725 State St., Racine, Wisconsin

Divisions: Electric Motor Corp., Cyclohm Motor Corp., Loyd Scruggs Co.

CIRCLE 123 ON READER-SERVICE CARD

## Marking Machine

262

Processes 2,000 pieces per hr

This automatic machine applies paint and dial fillers to depressed numerals, letters, and calibration markings at rates up to 2,000 pieces per hr. Designated model FWP-40, the machine indexes 3,000 cycles per hr. Parts can be unloaded automatically. Installation requires only the connection of exhaust facilities, compressed air, and electric power source.

Conforming Matrix Corp., Dept. ED, 476 Factories Bldg., Toledo 2, Ohio.

**Price & Availability:** \$6,000 to \$15,000 ea; made on order for 60-day delivery.

## Fluid Analyzer

263

Test purity of rinse waters

This automatic fluid analyzer can be used to test the purity of rinse waters and to sample the solid concentration of fluids used in the manufacture of electronic components. The basic data is produced on a filter membrane. A strip-chart recording attachment is also available.

Graver Water Conditioning Co., Dept. ED, 216 W. 14th St., New York 11, N.Y.

**Price & Availability:** \$2875 ea for the standard unit. Delivery is from stock.

## Kilns

264

With 0.75 to 16.7 cu ft capacities

These industrial box kilns are available in 18 sizes covering capacities of 0.75 to 16.7 cu ft. Operating at temperatures up to 2750 F, they are suitable precision electronic ceramics such as ferrites, steatites, and titanites. Equipped with silicon carbide hearths, the heating chambers are lined with insulating brick.

Harper Electric Furnace Corp., Dept. ED, 110 Pearl St., Buffalo 2, N.Y.

**Availability:** The unit is generally made on order with instrumentation furnished to meet customer specs.

## Oven

265

Provides to 500 F

This miniature batch oven has a temperature range of 100 to 500 F. At 260 C (500 F), control and uniformity are  $\pm 1$  C; at 200 C,  $\pm 0.5$  C. The oven permits processing of flat or odd-shaped work pieces without special loading. It can be used for operations such as baking, pre-heating, drying, and aging. Inside dimensions are 19 x 18 x 17.5 in. in diameter. Over-all dimensions are 29 x 43 x 30 in. in diameter.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.



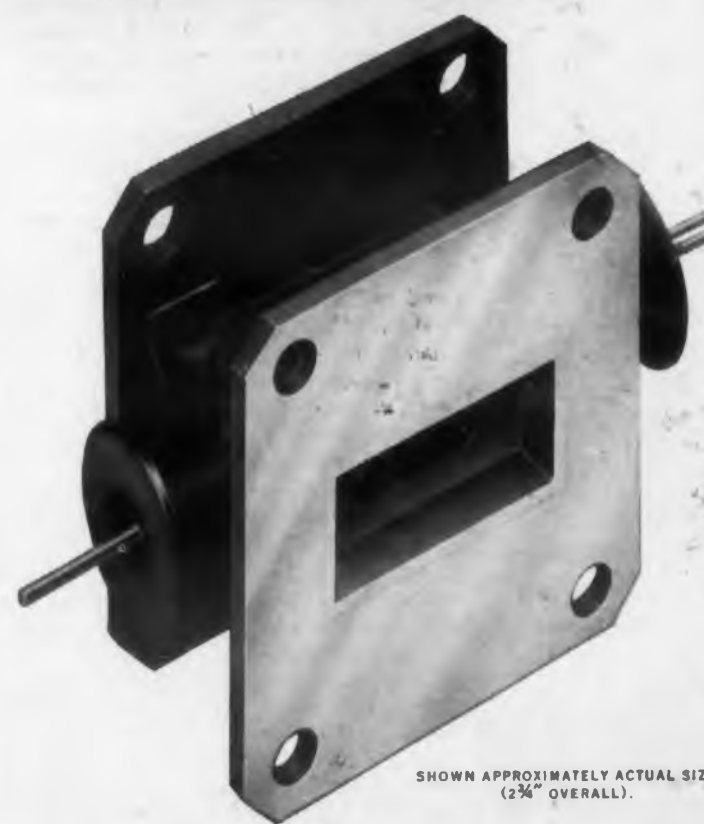
Microwave Component News from SYLVANIA



# New broad-band high-speed microwave switch

Now—a superior new device  
for your switching, duplexing  
and crystal-protecting  
applications

SYLVANIA'S RESEARCH in microwave components has resulted in an important new development which overcomes many of the disadvantages of existing microwave switching and duplexing devices. It is a hot-cathode, grid-initiated arc discharge switch with this unique combination of features:



SHOWN APPROXIMATELY ACTUAL SIZE  
(2 3/4" OVERALL).

- Suitable for high and low power applications
- Firing time of .1 - .3 microsecond
- Recovery time of the order of 1-10 microseconds
- Band width comparable to full waveguide band
- Consistent, reproducible phase of transmission and reflection

It has these specific advantages:

**SWITCHING APPLICATIONS**  
High-speed    Controlled firing    High isolation    Low loss

**DUPLEXING AND CRYSTAL PROTECTION APPLICATIONS**  
Negligible spike leakage  
Insertion loss as low as 0.2 db  
Maintains performance at low temperatures  
No noise contribution to receiver (no keep-alive current)  
Protects against RF power at lower levels than TR's

For engineering samples in C or X bands or information on units in other bands, contact your Sylvania sales office or write to  
*Sylvania Special Tube Operations*  
500 Evelyn Avenue, Mountain View, California

# SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**





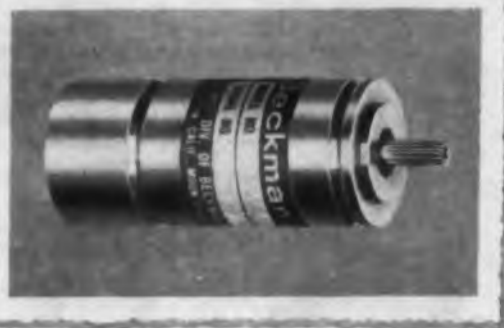
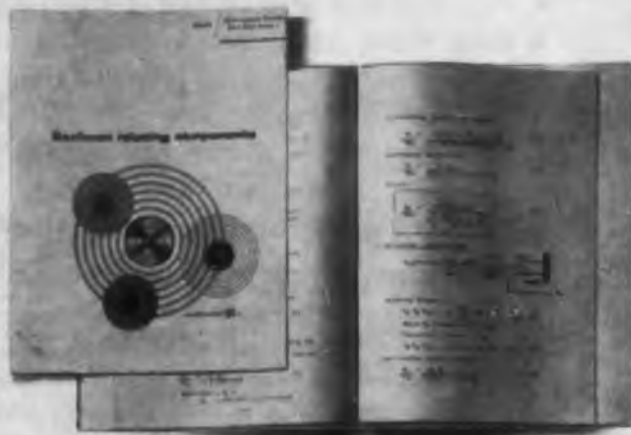
**HERE'S WHY VELOCITY DAMPING IMPROVES SERVOSYSTEM RELIABILITY...** The velocity-damp servomotor is a replacement for complicated rate-feedback loops—it achieves stability by simple and self-contained electromagnetic means.

For example, the **BECKMAN®** Size 8 Velocity-Damp Servomotor offers up to 25 dyne-cm.-sec./rad. additional damping, and can replace damping generators in 80% of present applications. In addition to elimination of phase shift and null voltage problems inherent in rate feedback systems, the velocity-damp unit is shorter, lighter, and consumes less power.

In **BECKMAN** Velocity-Damp Servomotors, damping is a direct function of velocity. A low-inertia drag cup, integral with the motor shaft rotates in a magnetic field generated by a pair of permanent magnets. Polarity of one magnet is variable with respect to the other, so that total force due to induced currents may be externally adjusted during operation.

In addition to Size 8 Velocity-Damp Servomotors, **BECKMAN** offers similar units in their Size 11, 15 and 18 lines.

For a complete delineation of servomotor damping theory... including transfer functions to help you determine damping needs... write for our Servo Brief entitled, "Electromagnetic Damping"



**Beckman Helipot®**

POTS : MOTORS : METERS  
Helipot Division of  
Beckman Instruments, Inc.  
Fullerton, California



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CIRCLE 124 ON READER-SERVICE CARD

## SERVICES FOR DESIGNERS

### Project and System Engineering 266

The principal areas of activity in which the company is involved are:

- Antennas and Radiation. The company is prepared to reduce customers' requirements to physical equipments.
- Communications and Navigation.
- Data Handling. The company's resources provide a range of customer services from problem analysis to complete system design.
- Detection and Identification.
- Flight Training and Simulation. The company offers to design and develop complete mission-type simulators for fixed and rotary-wing aircraft, radar and fire control, and missiles.
- Physical Sciences. A research materials laboratory performs research on the structure and application of new materials to support electronics.
- Reconnaissance.

Compliance with specification requirements are said to be insured through testing conducted at the company's extensive testing facilities. A Quality Control Department subjects both developmental units and production runs to the requirements and procedures of specifications at every significant stage of procurement, development, and construction where required.

The company's field organization also performs customer services, including: training of qualified customer personnel; pre-flight and flight-line checking; advanced base-shop maintenance; spare parts availability and handling, and test equipment support. Field service personnel are said to represent the company in such places as England, France, Germany, Denmark, Japan, Okinawa, and Morocco.

Melpar, Inc., Dept. ED, Engineering Services, 3000 Arlington Boulevard, Falls Church, Va.

### Potentiometer Testing 267

A completely equipped testing facility is now available to designers of precision potentiometers. Some of the special devices used to meet test requirements peculiar to certain precision potentiometers are:

- Linearity testers (0.008% master)
- Rotational life test machines (single and multi-turn)
- Equivalent noise test set
- Low temperature operation torque test set
- Open circuit detection device (24 units checked simultaneously—to 0.1 msec).

Among the standard equipments available at the facility are: vibration testers, military standard shock machines, altitude test chamber, life

## NATIONAL HR KNOBS

Precision made of the finest quality materials and recognized for excellence in design, National's line of HR Knobs are long a favorite of electronics people everywhere. Available in a number of types, styles, sizes and colors, National's comprehensive HR knob (and dial) line makes it possible to meet most of your knob requirements by ordering from catalog stock. A representative catalog listing:



**TYPE HRS:** Top quality Tenite, easy grip knurling, black or grey or to specifications; chrome plated bevel skirt, depressed numerals black enamelled; numbering 180° or 300°.

**TYPE HRT:** Modern, large knobs designed for NATIONAL's receivers, now available by popular request. DeLuxe, modern knob is made of black or grey Tenite; chrome plated inlay.

**TYPE HR:** Tenite, easy grip knurling, with or without white dot, or with special markings; black or grey or to specifications.

**TYPE HRB:** Lever knob is ideal for switching and for other applications where switch is turned to several index positions. Highly polished, bright zinc alloy die cast, or anodized in a variety of special colors. National Radio Co. also manufactures many other electronic and electromechanical components. For catalog covering your needs... or for your special design or applications problems, write or call:

**National RADIO CO., INC.**  
MELROSE 76, MASS. NORMANDIE 5-4800

A wholly owned subsidiary of National Co., Inc.  
Export: AD AURIEMA, INC., 85 Broad St., N.Y., N.Y., U.S.A.  
In Canada: CANADIAN MARCONI CO., 830 Bayview Ave.  
Toronto 17, Ont.

Specifications subject to change without notice.

WESCON, BOOTH 2522

CIRCLE 125 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

“  
Say,  
what's this  
I hear  
about LFE  
making  
read/write  
heads for  
magnetic drums  
and  
tape?”

“They have been  
making them  
for years  
for their own  
systems!  
Now they're  
available  
to the industry.  
Why don't you  
write for  
further info?”

**LFE**

LABORATORY FOR ELECTRONICS  
MAGNETIC DEVICES OPERATIONS  
COMPUTER PRODUCTS DIVISION  
1079 COMMONWEALTH AVENUE  
BOSTON 15, MASS. DEPT. 817 - E

Please send me complete data on  
your magnetic read/write heads.

Name \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Division \_\_\_\_\_

Address \_\_\_\_\_

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ELECTRONIC DESIGN • August 17, 1960

test apparatus, and high temperature oven. Standard electrical equipment for hi-pot, insulation resistance, angles, ratios, resistance and torque testing are also available.

Radio Corp. of America, Defense Electronic Products, Central Engineering, Bldg. 1-6, Dept. ED, Camden, N.J.

### New Datacenter 268

A new Datacenter Services tape facility has recently been opened in San Jose, Calif. The installation, using an IBM 704, is said to have a complete range of input-output and storage components. Included are: card readers, punches and printers; 10 magnetic tape units; and maximum core storage and magnetic drum units. IBM 7000 series equipment is expected to be available at a later date.

The organization also provides programing and machine services on IBM 700 series equipment in Boston, Chicago, Los Angeles, New York, and Washington, D.C.

Service Bureau Corp., Dept. ED, 425 Park Ave., New York 22, N.Y.

### Custom Teflon Shapes 269

The company is prepared to manufacture thin and standard wall spaghetti tubing, lightweight, industrial, aircraft tubing and small diameter rod to meet customer requirements. Wall thickness of the available tubing has a range from 0.005 in. and up.

Among the special extruded shapes that can be produced from T-6 powder are: channel, T, square, triangle, diamond, and oval tube.

Timely Technical Products, Inc., Dept. ED, S. Jefferson Road, Whippany, N.J.

### Technical Data Preparation 270

Company services involve the preparation of complex technical publications for aircraft, rocket and missile, and electronics manufacturers. Technical publications for every purpose, from research and development through field maintenance, can be produced.

The company has specialists in printed circuitry, logic boards, memory systems, data processing and reduction, and research and development documentation. Every major phase of literature production is thoroughly checked out in process, and at final stages.

Genge & Associates, Dept. ED, 1502 E. Colorado St., Glendale 5, Calif.

**TEMP-R-TAPE**<sup>®</sup>

pressure-sensitive tapes...

**CLASS H INSULATION**  
**FOR -100°F TO 500°F APPLICATIONS**

## CHR Temp-R-Tapes are easy to apply ...economical...dependable in service

Choose the right Temp-R-Tape for your job from a variety of types which combine some form of Teflon\*, Fiberglas or Silicone Rubber backing with a silicone polymer adhesive. Temp-R-Tapes are all pressure-sensitive, even those which are thermal curing, and adhere securely to most materials, including Teflon, at extremely high temperatures. Each of these versatile tapes possess a superior combination of electrical, mechanical and physical properties suitable for a variety of applications where high dielectric strength, thermal stability, moisture resistance, durability, low coefficient of friction, non-stick properties, non-corrosiveness, non-aging characteristics or fuel resistance may be required.

#### TYPICAL USES:

Electrical — slot lining; interlayer and interphase insulation; harness bundling; splicing; wrapping for microwave components, transformer coils, capacitors and high voltage cables. Mechanical — facings for film guides in electronic instruments, heat sealing bars, forming dies, chutes, guide rails, and for protection for metals and other materials being chemically cleaned or coated.

#### AVAILABLE FROM STOCK:

1/4" to 2" widths, 18 yd. and 36 yd. rolls and 12" width on liner by lineal yard. Special roll widths slit to order. Temp-R-Tape is sold nationally through distributors.

FREE SAMPLE and folder — write, phone or use inquiry service.

ELECTRICAL AND INDUSTRIAL SPECIALTY TAPES

**CHR CONNECTICUT HARD RUBBER CO.**

Main office: New Haven 9, Connecticut

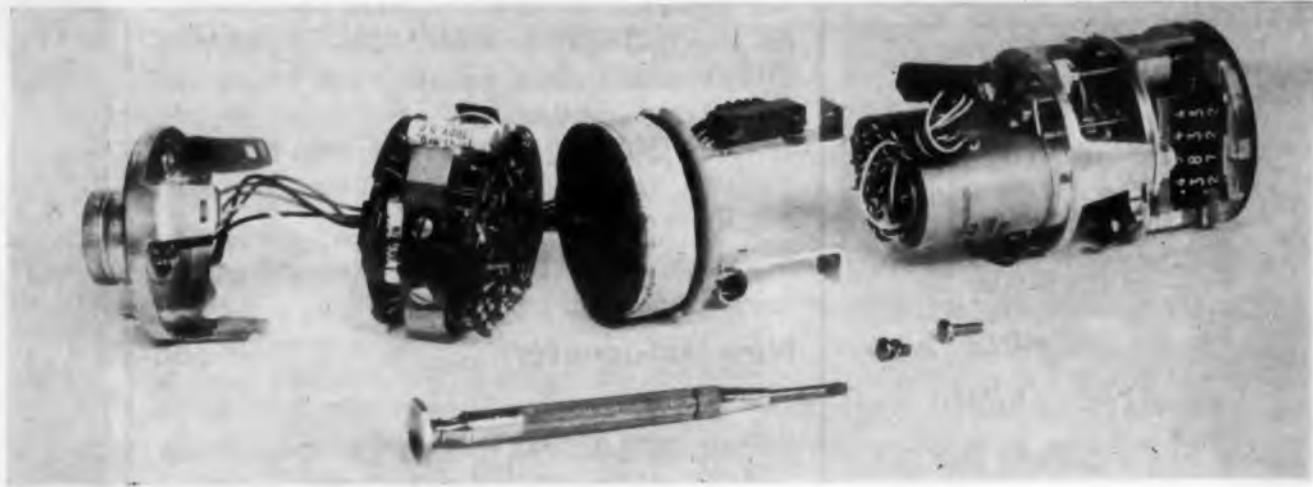
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\*duPont TM



## DESIGN DECISIONS

Featuring the clever and unusual in packaging appearance design and circuitry in electronic equipment.



## Compact, Servo-Operated Indicator



## Gives Analog and Digital Readout

**A**NALOG presentation for quick readout has been combined with digital presentation for precise readout in a 2-in. diam servo indicator of an aircraft fuel rate.

The analog presentation is obtained through a scale plate and pointer. It gives only a quick, approximate indication because only main divisions are on the dial. The digital presentation duplicates the pointer reading on a four-digit counter to provide a more precise indication. The last digit of the counter is a fixed zero to eliminate the need for a multiplying factor of ten.

The indicator, manufactured by General Electric's Instrument Dept., operates directly from a three-wire synchro-control transmitter. It consists of a three-stage transistor amplifier, a full-wave, silicon, isolated power supply, a motor-generator and a 400-cycle synchro-control transformer. The 6-1/4 in.  $\pm 1/16$  case length is closely controlled to permit mounting in fixed connection systems. The overall weight is 1.5 lb.

The total power input for steady state readings is under 7 w with approximately 3 w for the lighting system and 2 w to excite the fixed phase of the motor. The total power increases to approximately 8 w on signal because the push-pull output stage is operated Class B. This load is at 0.8 power factor. Push-pull stage gives out 0.3 w.

The amplifier drives the control phase of the servo-motor. The motor rotates to turn the con-

trol transformer rotor in a direction that reduces the pickup voltage in the rotor to effectively zero. The motor also rotates the indicator pointer and the counter to show the pounds per hour fuel flow through the transmitter. A small generator on the motor shaft provides a damping voltage proportional to the motor speed to make the indicator practically critically damped.

Power is obtained from the aircraft's 115-v  $\pm 15$  v, 400  $\pm 40$  cps, single-phase supply. Indicator accuracy is independent of variations within these tolerances, although some transmitters require a frequency-regulated supply for proper operation. One side of the 115-v line is grounded to the case, but may be insulated from it by removing an internal connecting lead. Warm up time, for practical purposes, may be considered as less than 10 sec.

The input signal is supplied by a three-wire, 400-cps control transmitter external to the indicator. Within the indicator, the input circuit consists of the three-wire stator winding of a control transformer. Each phase has approximately 90 + j340-ohm impedance and takes a maximum of 12 v (at 400 cps) per phase.

Internal lighting is provided by a light-conducting plastic scale plate and pointer system using three long-life, 5-v miniature bulbs. These are arranged to give a uniform red illumination of the scale, scale numbers, pointer and counter.

Lamps may be replaced when necessary during overhaul without removing the scale plate or pointer. Separate 5-v connections permit control of the light level and allow for operation on either ac or dc.

The readability of the low torque counter (cyclometer) is approximately 15 times that of the pointer. For example, a 20-PPH signal produces 0.02-in. motion at the pointer tip, while the same signal produces a 0.30-in. motion on the counter wheel surface. The special low-torque counter was developed to have a starting torque of less than 0.01 in.-oz. at 25 C. Careful cleaning and adjustment of the initial unit help maintain uniform counter characteristics throughout the life of the instrument.

The 1/8-in. high white on black background counter numbers are marked on 1/2-in. diam, external pinion, dull black nylon counter wheels. Nylon gives light weight for low inertia and long wear. The nylon bearing surfaces also provide a high degree of self lubrication for minimum torque over the operating temperature range.

Because this indicator has a non-linear scale, a metal flag is fastened to the "1000" wheel of the counter at the 5,000 PPH point to mask all counter numbers above 5,000. This feature permits using the digital readout for non-linear or stepped scale applications.

High counter accuracy, sensitivity and repeat-

A craft fuel indicator (shown partially assembled) is about 6-in. long with 2-inch diam. Fuel rate, in lb. per hr, is read approximately from scale with pointer (not shown) and more precisely from digital counter at right. The "unit" digit is fixed at zero to eliminate need for scale factor of ten.

ability are obtained by means of an antibacklash system that also eliminates critical gear adjustments and reduces gear wear. The sensitivity and repeatability are such that flow changes of less than 2 PPH in 6,000 PPH can be detected on the counter. Special accuracies up to  $\pm 0.05\%$  ( $\pm 3$  PPH in a 6,000-PPH scale) can be obtained over limited portions of the range when necessary.

The guaranteed accuracy of the indicator is  $\pm 20$  PPH over the 500- to 5,000-PPH range with most instruments well within  $\pm 10$  PPH.

Maximum system stability is provided by four negative feedback circuits in the amplifier and the rate generator feedback from the motor shaft. The approximate 38 db of negative feedback also helps maintain uniform performance despite normal variations in the components.

An output transformer, rather than direct drive, is used to couple the amplifier to the motor. This permits optimum amplifier output impedance for maximum power stability over the operating temperature range. The output transformer secondary is mismatched to the motor on the low impedance side at room temperature to improve the power match at higher temperatures.

The dc voltage for the amplifier is obtained from two IN459 silicon rectifiers in a center tap circuit with a 1.75  $\mu$ f tantalum filter condenser. The condenser also acts as a bypass for the center tap connection on the output transformer. The power transformer secondary is wound with No. 39 wire to provide inherent ripple-current-limiting resistance for the filter condenser for maximum component life.

Servicing and adjustment are facilitated by a coaxial arrangement of the assembly and the interconnecting plug between the front and rear sections. The set of interconnecting leads along one side permits folding back the interconnection socket, amplifier, power supply and mounting bracket for easy assembly and checking.

Fred J. Lingel, General Electric Co., Aircraft Instrument Engineering Sub-section, Instrument Dept., W. Lynn, Mass.

## Resolution up to 800 lines per diameter possible with new HUGHES flat-face TONOTRON® Tubes!

These newest products of HUGHES are especially designed to give you dramatically improved resolution in applications such as: shipborne and ground based radar, sonar, air traffic control, instrumentation, industrial TV, and many others.

HUGHES flat-face storage tubes, now available in quantity, enable you to increase display capability by a factor of 4. Display readouts are easier and more accurate because of the new picture clarity, sharper focus and finer detail provided by the optically-flat face and high light output of these new TONOTRON® Tubes from HUGHES.

Write today for full information and engineering assistance on your applications: HUGHES, Vacuum Tube Products Division, 2020 Short Street, Oceanside, Calif. For export information, please write: Hughes International, Culver City, California.

### FEATURES:

- Axial writing gun
- Electrostatic focusing
- Electromagnetic deflection
- P20 aluminized phosphor

Creating a new world with ELECTRONICS

**HUGHES**

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VACUUM TUBE PRODUCTS DIVISION

# FIRST 7" & 10" FLAT-FACE STORAGE TUBES



**100% HIGHER RESOLUTION!**

*another FIRST from HUGHES!*

See the complete line of HUGHES  
Storage Tubes on display at WESCON  
Booths: 2826-2827

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New tool for microminiaturization

# Now Build Your Own Micromodules with RCA's Basic Micromodule Laboratory Kit

RCA's new Basic Micromodule Laboratory Kit provides a revolutionary new way to meet the challenge of microminiaturization. It places full facilities for building and encapsulating experimental Micromodules directly in the hands of your own design group. From breadboard to finished Micromodule, you can evaluate your own circuits, assemble and encapsulate to your own specifications.

## COMPLETE KIT

The new kit provides all of the tools and instructions needed to convert many of your existing electronic-circuit designs into Micromodule equivalents: encapsulants, encapsulating mold, curing oven, cleaning materials, special microscope, special jigs, special air-abrading tools and automatic-control equipment—all are supplied with your Basic Micromodule Laboratory Kit. The only additional equipment you need to build your own sample Micromodules in your own laboratory is a tank of nitrogen and ten feet of workbench.

## STEP-BY-STEP INSTRUCTIONS

The Design Manual and Instruction Manual supplied with the kit give the step-by-step procedures for converting to Micromodular form and for building your own micromodules. The Design Manual shows, for example, how to divide circuits into units to suit Micromodule requirements—how to determine the positions of microelements in the assembled Micromodule—how to lay out the wiring for interconnections between Micromodules—how to make mechanical layouts. The Instruction Manual clearly explains and illustrates all of the techniques for building and testing experimental Micromodules. The stock of microelements and other components provided in the kit can be used for a wide range of circuit designs.

## DESIGN ADVANTAGES

Give your equipment designs the inherent advantages of microminiaturization now, with the RCA Basic Micromodule Laboratory Kit—component densities to several hundred thousand parts per cubic foot, greater reliability through redundancy, room to improve accuracy, precision, control, sensitivity, and selectivity.

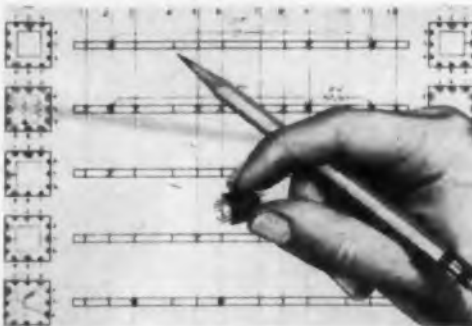
## AVAILABLE NOW

Your RCA Field Representative is ready to give you the details on the new RCA Basic Micromodule Laboratory Kit. He also has complete information on standard Micromodules available from stock for application in your new or existing designs. Remember, micromodularized end-equipment is probably your number one goal today—and it's ready for you now with RCA Micromodules. Give your local RCA office a call today!

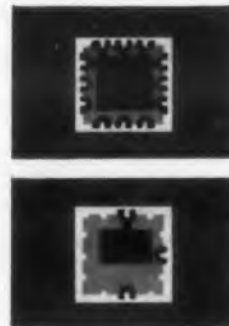
For your copy of RCA's new, complete Micromodule Design Manual, send \$2.00 today to RCA Semiconductor and Materials Division, Commercial Engineering Section H-18-NN-2, Somerville, N. J.



With RCA's easy-to-use new Basic Micromodule Laboratory Kit you design and assemble your own experimental Micromodules... minimize time lag between design and testing... eliminate outside engineering costs... maintain internal control of your new designs. Air-abrading technique illustrated makes it possible to tailor Micromodules to your own requirements from a minimum stock of "universal" microelements.



The Basic RCA Micromodule Laboratory Kit is furnished with all components, equipment and manuals necessary for designing, assembling and encapsulating your own experimental Micromodules from worksheet to finished Micromodule.



Microelement ceramic capacitor (magnified) with "universal" multiple terminations (top) can be abraded to give custom tailored capacitance values and provide the terminal arrangement you want (bottom).

## RCA SEMICONDUCTOR & MATERIALS DIVISION FIELD OFFICES

EAST: 744 Broad St., Newark, N. J., HUmboldt 5-3900. NORTHEAST: 162 Second Ave., Needham Heights 94, Mass., Hillcrest 4-7200. EAST CENTRAL: 714 New Center Bldg., Detroit 2, Mich., TRinity 5-5600. CENTRAL: Suite 1154, Merchandise Mart Plaza, Chicago, Ill., WHitehall 4-2900. WEST: 6355 E. Washington Blvd., Los Angeles, Calif., RAymond 3-8361 • 1838 El Camino Real, Burlingame, Calif., OXford 7-1620. SOUTHWEST: 7905 Empire Freeway, Dallas 7, Texas, FLeetwood 7-8167. GOV'T: 224 N. Wilkinson St., Dayton, Ohio, BAIdwin 6-2366 • 1725 "K" Street, N.W., Washington, D. C., FEderal 7-8500.



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## DESIGN DECISIONS

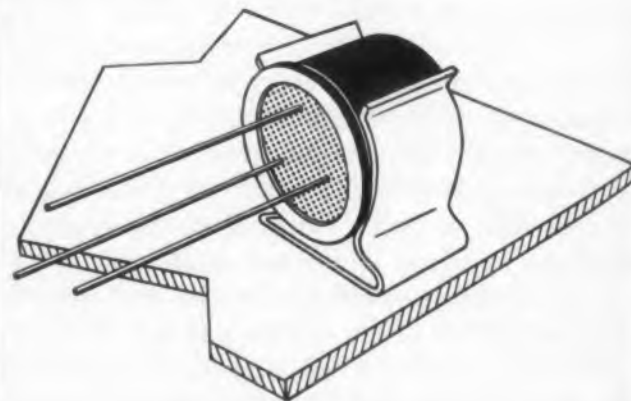
### Transistor Mount Saves Space, Cuts Production Cost

As part of a continuing program to improve printed-circuit boards, engineer Don Deutch of Epsco, Inc. in Cambridge, Mass., took a second look at conventional, transistor-mounting clips. He realized that they consumed space, they had to be fastened to a pc board, and they required an additional step—inserting the transistor.

He evaluated several types of mounts, and decided on a new type which simplifies board assembly, saves space, and cuts production costs.

Called a Transipad, the new device is a punched, laminated insulator. The transistor sits firmly on the insulator with its leads going through pre-punched holes. On a two-sided board or on a board using eyelets, the insulator prevents transistor leads from shorting to wiring on the card and from shorting between eyelets.

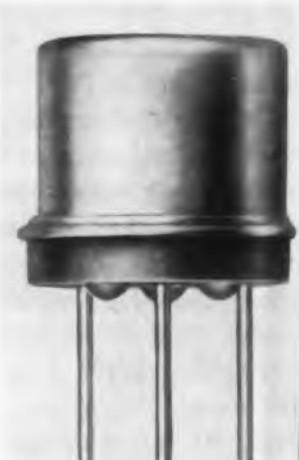
The Transipad, available from The Milton Ross Co., 237 Jacksonville Road, Hatboro, Pa., helps support the transistor and helps prevent leads from breaking at the seal during vibration or shock. It creates an air space between the board and transistor and thus protects the transistor during soldering. It also allows air to circulate under the transistor, reducing the possibility of moisture entrapment. This space also makes it easy to wash out solder flux.



Conventional transistor-mounting clip wastes space, according to Epsco engineer.



Transipad transistor mount saves space, cuts high cost of mounting transistors.



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- (4) Expose to high intensity arcs.
- (5) Develop. Fastest way: vapor-spray degreaser. Also may use tray or tank.
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## DESIGN

# Reflection Table Speeds Transmission Line Computations

Glyn Bostick

President, Radar Design Corp., Syracuse, N. Y.

A GREAT DEAL of the time consumed by transmission line computations can be laid to repetitive solutions. Solutions for many problem values have been carried out to slide-rule accuracy and are compiled in the accompanying table. The results are accurate enough for many purposes.

Some examples of the uses to which the table can be put are the following:

■ Voltage standing wave ratio (VSWR) can be converted to voltage reflection coefficient (R), or vice versa. These calculations are useful in interpreting reflectometer data.

■ A measured loss figure which can be separated into its two components, insertion loss and reflection loss.

■ Either or both VSWR and R can be converted into decibel notation. This is becoming an increasingly common practice. Filter attenuation curve for reflection-type filters, can be sketched in roughly. ■ ■

### REFLECTION TABLE

R	1/R	R <sup>2</sup>	R(db)	VSWR	VSWR (db)	Reflection Loss (db)
0.01	100.00	.0001	40.00	1.02	0.16	.0004
0.02	50.00	.0004	34.00	1.04	0.32	.0017
0.03	33.33	.0009	30.40	1.06	0.50	.0040
0.04	25.00	.0016	28.00	1.09	0.68	.0070
0.05	20.00	.0025	26.00	1.11	0.86	.0110
0.06	16.67	.0036	24.40	1.13	1.06	.0160
0.07	14.29	.0049	23.10	1.15	1.22	.0210
0.08	12.50	.0064	22.00	1.18	1.40	.0280
0.09	11.11	.0081	20.80	1.20	1.58	.0350
0.10	10.00	.0100	20.00	1.22	1.73	.0430
0.11	9.10	.0121	19.20	1.25	1.94	.0510
0.12	8.33	.0144	18.80	1.28	2.12	.0600
0.13	7.70	.0169	17.74	1.30	2.28	.0730
0.14	7.14	.0196	17.06	1.33	2.44	.0850
0.15	6.67	.0225	16.50	1.36	2.64	.0940
0.16	6.25	.0256	16.00	1.38	2.80	.1100
0.17	5.88	.0290	15.40	1.41	3.00	.1230
0.18	5.55	.0325	14.90	1.44	3.18	.1360
0.19	5.26	.0360	14.40	1.47	3.35	.1520
0.20	5.00	.0400	14.00	1.50	3.54	.1700
0.21	4.76	.0440	13.54	1.53	3.70	.1860
0.22	4.54	.0485	13.14	1.57	3.90	.2020
0.23	4.34	.0530	12.76	1.60	4.06	.2230
0.24	4.16	.0575	12.40	1.63	4.24	.2390
0.25	4.00	.0625	12.04	1.67	4.44	.2630
0.26	3.84	.0675	11.66	1.70	4.60	.3120
0.27	3.70	.0727	11.36	1.74	4.82	.3320
0.28	3.57	.0785	11.00	1.78	5.00	.3520
0.29	3.45	.0840	10.76	1.82	5.20	.3700
0.30	3.33	.0900	10.46	1.86	5.36	.4100
0.31	3.22	.0960	10.16	1.90	5.58	.4300
0.32	3.12	.1030	10.00	1.94	5.16	.4730
0.33	3.02	.1080	9.60	1.99	5.94	.4920
0.34	2.94	.1150	9.38	2.03	6.14	.5300
0.35	2.86	.1220	9.12	2.08	6.36	.5700
0.36	2.77	.1300	8.88	2.13	6.48	.6080
0.37	2.70	.1370	8.62	2.17	6.72	.6450

(table continued on p. 132)

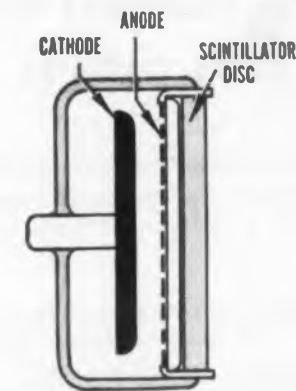
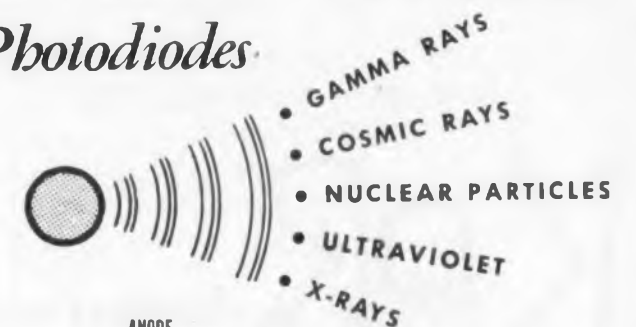


R	1/R	R <sup>2</sup>	R(db)	VSWR	VSWR (db)	Reflection Loss (db)
0.38	2.62	.1440	8.36	2.23	6.94	.6800
0.39	2.57	.1520	8.20	2.28	7.16 <sup>(w)</sup>	.7200
0.40	2.50	.1600	7.96	2.34	7.34	.7550
0.41	2.43	.17	7.70	2.38	7.50	.8100
0.42	2.38	.18	7.54	2.45	7.76	.8300
0.43	2.32	.18	7.30	2.51	8.00	.8700
0.44	2.27	.19	7.12	2.57	8.20	.8800
0.45	2.22	.20	6.92	2.63	8.40	.9700
0.46	2.17	.21	6.72	2.70	8.60	1.0400
0.47	2.12	.22	6.54	2.77	8.84	1.0900
0.48	2.08	.23	6.38	2.84	9.08	1.1400
0.49	2.03	.24	6.14	2.92	9.30	1.2100
0.50	2.00	.25	6.00	3.00	9.52	1.2500
0.51	1.96	.26	5.86	3.08	9.76	1.3100
0.52	1.92	.27	5.68	3.17	10.00	1.3700
0.53	1.89	.28	5.54	3.25	10.20	1.4300
0.54	1.85	.29	5.36	3.35	10.50	1.5000
0.55	1.82	.30	5.20	3.44	10.74	1.5600
0.56	1.78	.31	5.04	3.55	11.00	1.6200
0.57	1.75	.32	4.88	3.65	11.20	1.7100
0.58	1.72	.33	4.74	3.77	11.54	1.7800
0.59	1.69	.35	4.60	3.88	11.80	1.8700
0.60	1.66	.36	4.42	4.00	12.00	1.9300
0.61	1.64	.37	4.30	4.13	12.30	2.01
0.62	1.61	.38	4.14	4.27	12.60	2.10
0.63	1.59	.39	4.00	4.40	12.86	2.18
0.64	1.56	.41	3.86	4.55	13.16	2.30
0.65	1.54	.42	3.76	4.72	13.46	2.38
0.66	1.52	.43	3.62	4.88	13.76	2.46
0.67	1.49	.45	3.46	5.06	14.08	2.60
0.68	1.47	.46	3.36	5.25	14.40	2.67
0.69	1.45	.47	3.24	5.39	14.60	2.77
0.70	1.43	.49	3.12	5.67	15.06	2.93
0.71	1.41	.50	3.00	5.90	15.40	3.04
0.72	1.39	.52	2.88	6.14	15.80	3.18
0.73	1.37	.53	2.74	6.40	16.20	3.28
0.74	1.35	.55	2.62	6.69	16.50	3.47
0.75	1.33	.56	2.50	7.00	16.90	3.57
0.76	1.32	.58	2.38	7.33	17.30	3.75
0.77	1.30	.59	2.28	7.69	17.76	3.90
0.78	1.28	.61	2.14	8.08	18.20	4.11
0.79	1.27	.62	2.02	8.52	18.60	4.22
0.80	1.25	.64	1.94	9.00	19.10	4.44
0.81	1.24	.65	1.88	9.53	19.60	4.62
0.82	1.22	.67	1.73	10.10	20.10	4.80
0.83	1.205	.69	1.62	10.75	20.60	5.10
0.84	1.19	.70	1.52	11.50	21.20	5.30
0.85	1.18	.72	1.44	12.34	21.80	5.53
0.86	1.17	.74	1.33	13.30	22.50	5.85
0.87	1.15	.76	1.22	14.40	23.20	6.20
0.88	1.14	.77	1.10	15.67	24.0	6.50
0.89	1.13	.79	1.02	17.20	24.70	6.90
0.90	1.11	.81	0.92	19.60	25.60	7.20
0.91	1.10	.83	0.82	21.25	26.50	7.70
0.92	1.09	.84	0.74	24.00	27.60	8.10
0.93	1.08	.86	0.66	27.60	28.80	8.70
0.94	1.07	.88	0.58	32.40	30.20	9.40
0.95	1.05	.90	0.42	39.00	31.80	10.00
0.96	1.04	.92	0.34	49.00	35.8	11.00
0.97	1.03	.94	0.25	65.70	36.4	12.20
0.98	1.02	.96	0.17	99.00	40.00	13.90
0.99	1.01	.98	0.09	199.00	46.00	17.00
1.00	1.00	1.00	0.00	∞	∞	∞






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**ELECTRONIC DESIGN • August 17, 1960**

## NEW LITERATURE

### Aluminum Parts 271

The full range of shapes, sizes, and alloys available in primary aluminum pig, ingot, and billet are reviewed in this 12-page brochure. Complete metallurgical tables are included. Light and heavy press extrusions, press forgings, hand forgings, impact extrusions, pipe, tubing, and other commodities made by the company are listed. Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif.

### Precision Instrument Bearings 272

High precision thin-width instrument bearings, designed for use with synchros, potentiometers, servos and small motors, are described in bulletin No. 6002, four pages. The illustrated bulletin covers dimensions, such as bore, outside diameter, width, and ball size. Also covered are number of balls and approximate weight in grams. Miniature Precision Bearings, Inc., Precision Park, Keene, N.H.

### Optical Comparators 273

This 20-page booklet is intended as a brief introduction to optical comparators. It describes the kinds of measurements that are possible with the instruments, and also covers specific applications as seen in inspection areas. The illustrated booklet gives construction features of the instruments. Jones & Lamson Machine Co., Springfield, Vt.

### RF Test Equipment 274

This 12-page catalog describes rf test equipment for quantitative measurements. Measurement of amplifier gain, vswr and equipment loss are also described, and examples of each are illustrated. Equipment described includes sweep generators, marker generators, comparators, detectors, terminators and transfer switches. Jerrold Electronics Corp., Industrial Products Div., Jerrold Building, Philadelphia 32, Pa.

### Dry Type Transformers 275

Dry type power distribution transformer catalog No. 5A2-BLO1 includes basic definitions and explanations of transformer terminology as a ready-reference handbook. In addition to full listings of transformer ratings from 1/10 to 167 kva, single phase, and 3 to 500 kva, three phase, the catalog also includes a full series of connection diagrams for all voltage ratings. Illustrations of construction features show how designs provide for automatic internal air cooling and how coils are mechanically stabilized in case of heavy current surges. Acem Electric Corp., Cuba, N.Y.



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This newly developed triode is also well suited for such applications as broadcast, FM and single-sideband transmitters, ultrasonic generators and sonar pulse amplifiers. It can also be used as a class-AB<sub>2</sub> or class-B linear amplifier in audio or r-f service.

A companion air-system socket and chimney, as shown above, is available with the 3CX10,000A3 to meet your specific requirements. Watch for a low mu version of this high-power triode in the near future.

#### GENERAL CHARACTERISTICS

EIMAC 3CX10,000A3	Height	Diameter	Max. Operating Temp.	Filament Voltage	Filament Current	Frequency for Max. Ratings	Max. Plate-Diss. Rating
CERAMIC TRIODE	8.25"	7.0"	250°C.	7.5	102 amp.	110 Mc.	10,000 watts

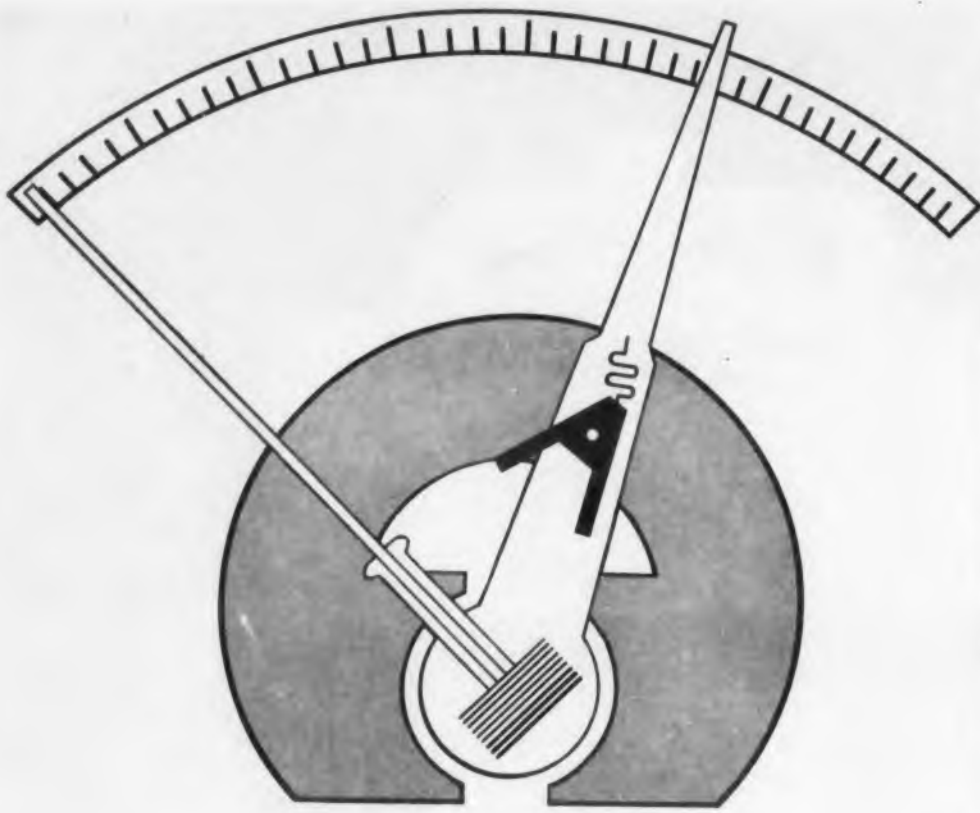
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## NEW LITERATURE

### Proximity Meter 276

Booklet No. TM-951-2 contains a complete description, circuit and dimensional information, and numerous application specifics including layout and configuration details of a capacitance operated proximity meter. The 28-page manual also contains performance and adjustment figures with sufficient data to permit modification to or application for purposes that require measurement of physical displacement, dielectric constant or cyclic motion. Robertshaw-Fulton Controls Co., Aeronautical and Instrument Div., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

### Nonferrous Alloys 277

A detailed chart showing comparative specifications, chemical analyses, and minimum physical properties of nonferrous alloys is included in eight-page bulletin No. 157. It also describes component parts and assemblies regularly produced by the centrifugal method. The Shenango Furnace Co., Centrifugally Cast Products Div., Dover, Ohio.

### Constant Temperature Block 278

The Thermomatic constant temperature block is described in two-page bulletin No. 778. It lists performance features, applications, and specifications. Photographs are included. Beckman Scientific and Process Instruments Div., Technical Information Dept., 2500 Fullerton Road, Fullerton, Calif.

### Ferrite Devices 279

This four-page catalog on ferrite devices lists electrical characteristics and over-all length for more than 60 models of coaxial isolators, broadband and special-purpose waveguide isolators, "Tee" circulators, and phase-shift circulators. Photographs are included. Sylvania Electric Products Inc., Central Advertising Distribution Dept., 1100 Main St., Buffalo, N. Y.

### Ultraviolet Spectrophotometers 280

The DB ultraviolet spectrophotometer is described in four-page bulletin No. 779. Photographs, diagrams, and graphs are included. Beckman Scientific and Process Instruments Div., Technical Information Dept., 2500 Fullerton Road, Fullerton, Calif.

### Flange Seals 281

This wave guide conversion chart for flange seals shows all wave band series and various seals produced by the firm to fit standard flanges. It includes dimensions and other pertinent data useful for checking materials, sizes, etc. Parker Seal Co., 10567 Jefferson Blvd., Culver City, Calif.

### Automatic Soldering Systems 282

Details on the automatic printed-circuit board soldering systems are covered in Catalog No. A. 1090. Radio Corporation of America, Industrial and Automation Div., Building 15-1, Camden, N. J.

### Carbon and Graphite Products 283

This eight-page brochure includes detailed data on the mechanical, chemical and electrical properties of carbon and graphite. Recommended techniques for machining carbon and graphite parts are outlined. Charts, graphs, dimensional diagrams and illustrations are included. Merle Lecker, Speer Carbon Co., St. Marys, Pa.

### Hydrogen Flame Detectors 284

A hydrogen flame detector is described in six-page bulletin No. 781. Operating characteristics and principles, specifications, and typical chromatograms are included. Beckman Scientific and Process Instruments Div., Technical Information Dept., 2500 Fullerton Road, Fullerton, Calif.

### Oscilloscopes 285

This brochure gives specifications and details of the model 104E memoscope oscilloscope. It also provides specifications and information on the oscilloscope care and other accessories. Hughes Industrial Systems Div., International Airport Sta., Los Angeles 45, Calif.

### Panel Meters 286

Bulletin GEA-7034, 12 pages, gives descriptive and buying information on the 2-1/2, 3-1/2, and 4-1/2 in. panel meters. It includes a description of product features and specifications, and dimensions, plus a description of custom features for special applications. General Electric Co., Schenectady 5, N. Y.

## Welder Transformers 287

Twenty-page Bulletin No. SP-23 contains data on resistance welder transformers. It gives construction techniques, transformer rating and load demand, magnetizing and load transients, application and duty cycle; formulas are provided for calculating kva loading at various duty cycles. Photographs, schematic diagrams, drawings, charts and graphs are included. The Taylor Winfield Corp., Warren, Ohio.

## Digital Voltmeters 288

Two-color, four-page bulletin No. 64-1 compares the full four-digit V64 with pointer meters and three-digit voltmeters in price and usefulness. Two-color photos illustrate the features in a two-page section entitled "Low-Cost Answer to Superior Visual Voltage Measurements." Other sections cover the instrument's applications and specifications. Non-Linear Systems, Inc., Del Mar, Calif.

## Alloy Wire 289

Performance characteristics, description and tables showing diameters of wire available are shown in Ceron ST data sheet, two pages, on resistance alloy wire. Complete specification data are given. The Kanthal Corp., Amelia Place, Stamford, Conn.

## Starters and Contactors 290

Six-page folder, Form A-262 titled "1/2 The Size of Conventional Controls," defines the principle of the "RA" design. It also provides brief explanations of the technical and design features of the controls. A free copy of a handy reference catalog is offered. Photographs are included. Arrow-Hart & Hegeman Electric Co., Industrial Control Div., 103 Hawthorn St., Hartford 6, Conn.

## Polymers 291

This revised 12-page polymer directory and catalog, intended primarily for research and professional use, lists properties, end uses, and other technical data for more than 150 polymers. Some products covered are polyvinyl acetate homopolymer emulsions, copolymer solutions and bead resins, and butadiene-styrene emulsions. The Borden Chemical Co., Dept. H, 350 Madison Ave., New York 17, N. Y.

## Meters and Power Supplies 292

Catalog No. C-260-1, four pages, illustrates 17 different products and provides technical data sufficient for preliminary evaluation of each instrument listed. Specifications cover voltage, current, accuracy, regulation, stability, maximum ripple, resolution and price. John Fluke Manufacturing Co., Inc., Box 7161, Seattle 33, Wash.

## Logarithmic Converter 293

Application note AN-101, four pages, describes the use of Model 60 B logarithmic converter as a computing element. The note explains how it can perform multiplication and division when used in pairs and with a suitable read-out device. F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.

## Microwave Measurements

This 106-page handbook is entitled "Microwave Measurements For Calibration Laboratories." It is divided into five sections covering: a general introduction and brief description of techniques; frequency measurements and time comparisons; attenuation measurements with square-law detection and with linear detection; impedance, SWR, directional coupler and reflection coefficient measurements; power measurements with a power meter, bolometer bridge and calorimetric power meter. The addenda includes four parts which cover: bolometer efficiency measurement; operating notes on a line length set; rf pulse carrier frequency measurement, and flow-graph measurement techniques. Write on company letterhead to Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

## Coaxial Connectors 294

Complete details of microminiature, snap-locking coaxial connectors appear in this six-page catalog. Included are electrical, mechanical and environmental specifications, and outline drawings. A variety of plugs, receptacles, caps and adapters are shown in 50, 75 and 95 ohm impedances. Friction-held, push-on connectors for rack and panel installations; miniature coaxial cable and accessories; and a separate price list complete the catalog. Electro-Physics Laboratories, Technical Information Service, 2065 Huntington Drive, San Marino, Calif.



Highly precise and accurate, Kearfott two-axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them. An inverted pendulum utilizing a unique Hooke's joint suspension displaces as a function of acceleration in either of 2 axes. An AC pickoff signal is rectified and applied to voice coils restoring the pendulum to null. The DC required for restoration is proportional to acceleration. Typical characteristics for these units include range of  $\pm 25$  g's, scale factor of 5.0 ma/g, linearity of  $\pm 0.005\%$  and threshold of  $2 \times 10^{-7}$  g's.

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BULLETIN NO. 520 AVAILABLE

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BLILEY  
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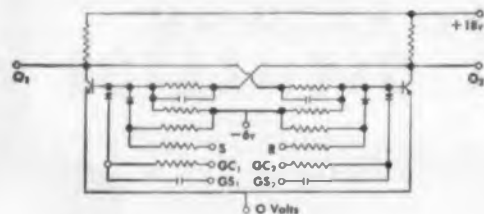
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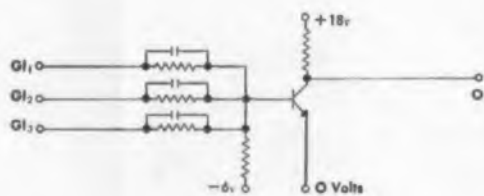


Series M Transistor Logic Elements now provide maximum reliability and high frequency performance over an extended temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Pre-designed for immediate use in breadboard, prototype or production equipment, these compatible logic modules find versatile defense applications in digital computer and data handling systems. Encapsulation in high-temperature epoxy material, semi-transparent for easy inspection of internal assembly, affords protection from extreme environmental conditions of humidity, shock and vibration. Metal feed-through sleeves improve mounting flexibility, while uniform packaging and terminal arrangement facilitate interconnection of modules.

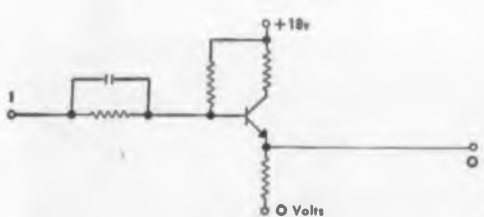
Reasonably priced and available for prompt delivery, General Electric Transistor Logic Elements are manufactured from thoroughly tested, quality components. These saturating and resistance-coupled modules are also offered in circuit and packaging variations, custom designed to meet specific engineering requirements.



**Transistor Binary (Type M-264)** —provides two gate control inputs, two gate signal inputs, and two direct resistance inputs for the set and reset of the flip-flop. Intended for use in counters and shift registers, it drives up to four, fully loaded, Series M Transistor NOR-Gates at each of the two outputs.



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## NEW LITERATURE

### Brazing Alloys 295

Analysis and comparisons of various low temperature brazing alloys appear in this four-page folder. Included are low fuming bronze, nickel silver, silver solder, phos sil 0, 2, 6, 6F and 15 alloys, aluminum welding wire and flux. Comparison charts are also included. American Brazing Alloys Corp., Box 11, Pelham, N.Y.

### Coaxial Connectors 296

Technical data on the TNC series of coaxial connectors are contained in this 12-page catalog. It includes a TNC functional diagram which graphically illustrates types and flow of connectors by various cable sizes. Also included is a comprehensive presentation on calibrated reliability with accompanying graphs. Kings Electronics Co., Inc., 38 Marbledale Road, Tuckahoe 7, N.Y.

### Ceramic Capacitors 297

The U.L. series of Ceramite capacitors for line bypass and antenna coupling applications is described in this two-page data sheet. The illustrated bulletin contains an outline drawing, popular rating table, and complete performance specifications. Sprague Electric Co., N. Adams, Mass.

### Tape Degausser 298

The DataTape 5-055A automatic tape degausser is described in this two-page bulletin No. 1631. The unit is said to erase signals from 1/4 to 2 in. magnetic tape wound on reels seven to 14 in. in diameter. The illustrated bulletin describes the unit's automatic operation. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

### Printed Circuit Boards

Printed circuit board characteristics are reported in this bulletin, No. CE-3.00. It reports that the company's Fotoceram boards are made of a glass-ceramic material. Circuit designs are reproduced precisely by a photographic process. The bulletin also states that components can be resoldered more than 50 times without damaging circuit runs. Write on company letterhead to Corning Glass Works, Electronic Components Dept., Dept. ED, Bradford, Pa.

### Instrument Selection Guide 299

This six-page instrument selection guide covers digital voltmeters, ratiometers, ohmmeters, voltage and resistance comparators and associated measuring equipment. It compares the company's digital instrument series by application, features and specifications. Accessory equipment is also illustrated. Non-Linear Systems, Inc., Del Mar, Calif.

### Constant Delay Lines 300

This brochure entitled "Delay Lines—Basic Design Considerations," gives design information necessary to calculate the circuit parameters and size of the delay line for a specific application. The booklet also discusses design compromises aimed at reducing sizes or expense. Cornell-Dubilier Electric Corp., Marketing Dept., 4144 Glencoe Ave., Venice, Calif.

### In-Line Switch 301

Catalog No. 7300-A describes the Digi-switch unit, an electro-mechanical switching device which commutates a dial setting input to a coded electrical output. The catalog describes circuit codes available in single and double pole decimal, binary coded decimal and octal binary notations. Installation data are also included. Digitran Co., 660 S. Arroyo Parkway, Pasadena, Calif.

### Power Amplifier 302

Model 205J-1 linear power amplifier is described in this bulletin, eight pages. A functional block diagram graphically illustrates the power amplifier circuits and control circuits. Data is included on automatic tuning and loading, distortion, harmonic output, noise level, emission, input information required, and rf bandwidth. Associated equipment is also described. Collins Radio Co., Box 1891, Dallas, Tex.

### Power Supply 303

This illustrated two-page data sheet describes model HP 3615 solid-state dc power supply. Specifications cover static load regulation, dynamic load regulation, recovery time, stability, overload precision, ripple and noise, and controls. Deltron, Inc., 2905 N. Leithgow St., Philadelphia 33, Pa.

### Inertial Guidance Equipment 304

Brochure No. 153, 24 pages, covers inertial guidance test equipment and components. The booklet combines specifications and photographs on precision turntables, rate tables, air bearing and fluid bearing tables, electronic test equipment and consoles, and various related products. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, Long Island, N.Y.

### Projector-Printer 305

The Kecofox projector-printer is described in this four-page bulletin. The operation of the machine is briefly outlined in the illustrated bulletin. Specifications include print size range, negative requirements, and print cycle. Keuffel & Esser Co., Third and Adams St., Hoboken, N.J.

### Machinery Mounts 306

The company's machinery mounts are described in this six-page bulletin, No. 60-04. It illustrates how the mounts improve precision, reduce maintenance costs, and improve employee performance. Barry Controls, Inc., 700 Pleasant St., Watertown 72, Mass.

### Checkout Equipment 307

This four-page, illustrated brochure describes an rms-to-dc converter, a megacycle universal timer-counter, a four-decimal digit voltage-digital converter and a digital printer available in plug-in modular form. These instruments, suitable for ground-based military installations, comply with MIL 4158B. Electrical operating characteristics for each instrument are included in the brochure. Equipment Div., Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass.

### Zener Diode Study

This study of Zener diodes and Zener reference elements is prefaced by an introduction to semiconductor theory and reverse breakdown, and followed with a detailed and illustrated examination of design considerations, thermal and operating characteristics, and discussions of Zener diode: ac and dc applications; audio and rf applications; computer and instrumentation applications, and circuit protection applications. For copies of the 100-page handbook, send \$2.00 to International Rectifier Corp., Dept. ED, 1521 E. G and Ave., El Segundo, Calif.

### Laboratory Standards 308

This 23-page illustrated brochure, "World Standards," details and diagrams each major component of precision electrical instruments, including construction and choice of special materials. Instruments described include voltmeters, ammeters, wattmeters, current transformers and standardizing potential transformers. A supplementary data section on transformer ratio and phase-angle curves indicates necessary corrections for residual errors that instrument transformers may introduce into a measuring system. Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.

### Industrial Laminates 309

This 16-page catalog, No. L-CDL-494, on Testolite industrial laminated plastic sheets, tubes and rods lists applications, special features, detailed characteristics and sizes available in over 50 grades. Included are phenolics, silicones, melamines and epoxies with filler bases of paper, nylon, cotton, asbestos and glass fabric. Also shown are features and properties of copper-clad laminates for printed circuits. General Electric Co., Laminated Products Dept., Coshocton, Ohio.

### Recorder 310

This two-page bulletin, No. 794-1, describes a 24 x 36 in. XY recorder offering direct differential transformer or ac transducer input. Technical data on and a functional block diagram of the instrument are included. Houston Instrument Corp., P. O. Box 22234, Houston 27, Tex.

### Rectifier Analyzer 311

This technical data sheet describes the firm's self-contained Model 141A 20-amp rectifier analyzer designed for production and laboratory applications. Curves of operating characteristics are included. Wallson Associates, Inc., 912-914 Westfield Ave., Elizabeth, N. J.

### Power Supplies 312

This two-page data sheet, No. PS2103, describes a series of miniature plug-in, solid-state power supplies. Electrical and physical characteristics are included for seven models covering voltage ranges of 1 to 100 v with currents up to 2 amp. Deltron Inc., Philadelphia 33, Pa.

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Specifically designed for missile applications, these Kearfott miniature gyros are available with short term drift rates of 0.01°/hr. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Wide angle displacement gyros with high torquing rates for "strap-down" applications are also being produced. Performance characteristics that are even more precise can be provided within the same dimensions.



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## NEW LITERATURE

### Germanium Diodes 313

Bulletin No. 158 lists all "IN" germanium diodes produced by the company. Altogether, the bulletin lists 223 different "IN" diodes and 390 "OMC" diodes. Parameters are given in tabular form. Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill.

### Solder Preforms 314

Technical data bulletin No. Z-103, a two-page report, describes ultrapure precision solder preforms. Compositions and melting points of 33 typical alloys are listed. A photograph shows the various shapes available. Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N. Y.

### Nuclear Instruments 315

Nuclear instruments described in this four-page bulletin include: stable microammeter, high-voltage power supply, log-N period amplifier, log count rate meter, log count rate meter with period, linear count rate meter, preamplifier, flux amplifier and actuator amplifier. General Electric, Schenectady 5, N. Y.

### Spectrophotometer 315

This pocket-size booklet describes the model 505 recording spectrophotometer. Data given include: wavelength range, band pass, accuracy, scanning time and dispersion. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

### Tape Transport 317

Complete specifications, application information and characteristics of the series 3170 magnetic tape transports are described in bulletin No. DS 3170A. Two, six, ten and twelve speed models of the transport are covered. Flutter curve is included. Minneapolis Honeywell Regulator Co., Industrial Systems Div., 10721 Hanna St., Beltsville, Md.

### Rhodium Plating

A plastic laminated instruction sheet on the use of rhodium plating solutions includes data on equipment, area calculations and useful equivalents. The sheet is designed for mounting on or near rhodium plating tanks for quick reference. Methods for determining the cost of a plated sur-

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ELECTRONIC DESIGN • August 17, 1960

face and how to correct common plating defects are outlined. Write on company letterhead to Texas Instruments, Inc., Metals & Controls Div., Dept. ED, 34 Forest St., Attleboro, Mass.

### Hardware Catalog 318

Listed in catalog No. 62 is the company's line of electronic hardware and resistors. Included in the 96-page booklet are bearings, brackets, bushings, couplings, fasteners, ferrules, chassis handles, collet knobs, pot shaft locks, and posts. Among the resistors covered are silicone coated resistors and tapped resistors. Sterling Precision Corp., Instrument Div., 5 Sintsink Drive E., Port Washington, Long Island, N. Y.

### Variable Resistors 319

This four-page Technical Bulletin, No. A-3b, on 2-W wire wound variable resistors contains three illustrations, 13 dimensional drawings, electrical and mechanical specifications. Performance specifications for "L" and "T" pad controls and a table of standards for flatted and slotted shafts are included. CTS of Asheville, Inc., Skyland, N. C.

### Electro-Mechanical Parts 320

The company's principal lines of differential transformers, transducers and accelerometers for use in measuring, indicating, recording and control, are presented in this four-page short form catalog. Schaevitz Engineering, Box 505, Camden 1, N. J.

### Push-Button Switches 321

Push-button switches in single and double row assemblies of from four to 12 stations, with interlocking action, illuminated or non-illuminated, are described in bulletin No. 7000. Included are photographs, dimension drawings and detailed specifications. Donald P. Mossman, Inc., Brewster, N. Y.

### Chilling Equipment 322

Large capacity production chilling equipment for stabilization of metals, stress relief of castings, dehydration of gases, expansion assembly and other production chilling applications is described and illustrated in this two-page data sheet. Cincinnati Sub Zero Products, 3932 Reading Road, Cincinnati 29, Ohio.



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### Gated-Beam Tube Has Novel Multivibrator Application

Combining a gated-beam vacuum tube with two resistors and a capacitor yields a novel and useful multivibrator circuit. Usually applied as a limiter or fm discriminator, a 6BN6 connected as in Fig. 1 will provide an astable output. With some modification the circuit will be monostable. The filament power required is less than 1 w.

Since the cathode current in the 6BN6 is essentially constant regardless of the grid voltages, plate current can only increase at the expense of accelerator current.

As the grid voltage increases, the plate current increases and the accelerator current decreases. This increases the accelerator voltage. Since the accelerator voltage is in phase with the grid voltage, if the accelerator is capacitively coupled to the grid, positive feedback will occur. A 5.6 K resistor provides voltage gain from the grid to the accelerator. Therefore, regeneration occurs and the result is astable vibration.

A plate resistor can be inserted if a negative output pulse is desired.

For greater plate output the quadrature grid is connected to the plate as shown in Fig. 2 and a higher voltage is used.

A univibrator, or one-shot multivibrator can be obtained by inserting a cathode resistor (470

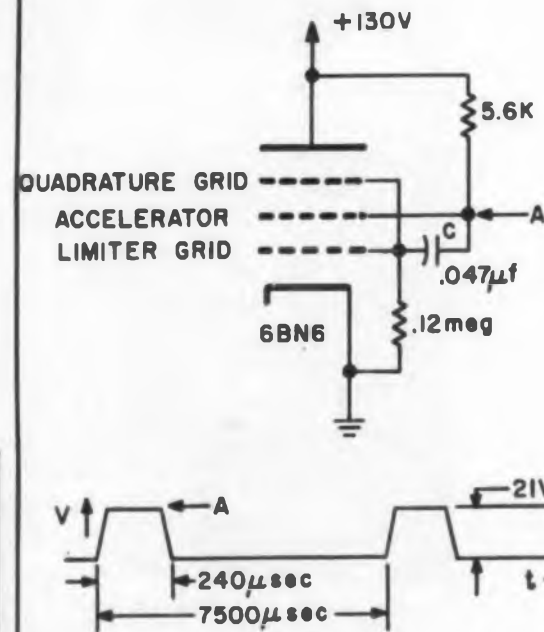


Fig. 1. Positive-going astable output is taken from the accelerator of the 6BN6 tube.

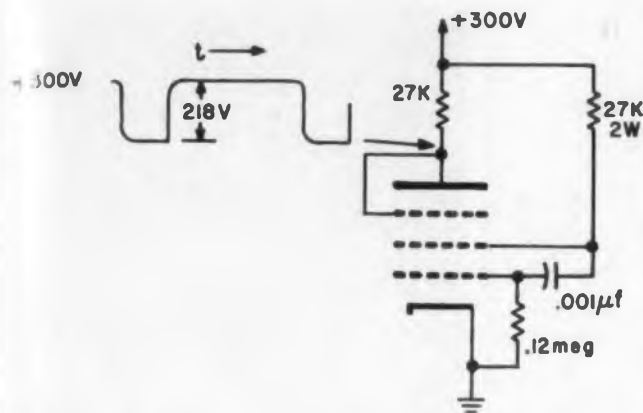


Fig. 2. Circuit has a greater voltage when the quadrature grid is connected to the plate instead of the limiter.

ohms) so that the voltage across it is sufficient to bias the tube to plate current cutoff. When this occurs, all the cathode current, as previously mentioned, travels to the accelerator. When a positive trigger is applied to the grid, the univibrator will produce an output pulse.

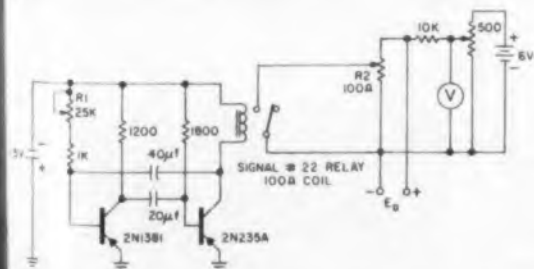
Incidentally, the waveforms have practically no over-shoot since the grid draws very little current when driven positive.

Alfred W. Zinn, Engineer, Farrand Optical Co., Inc., New York, N.Y.

### Pulsed Relay Generates Low Level Step Functions

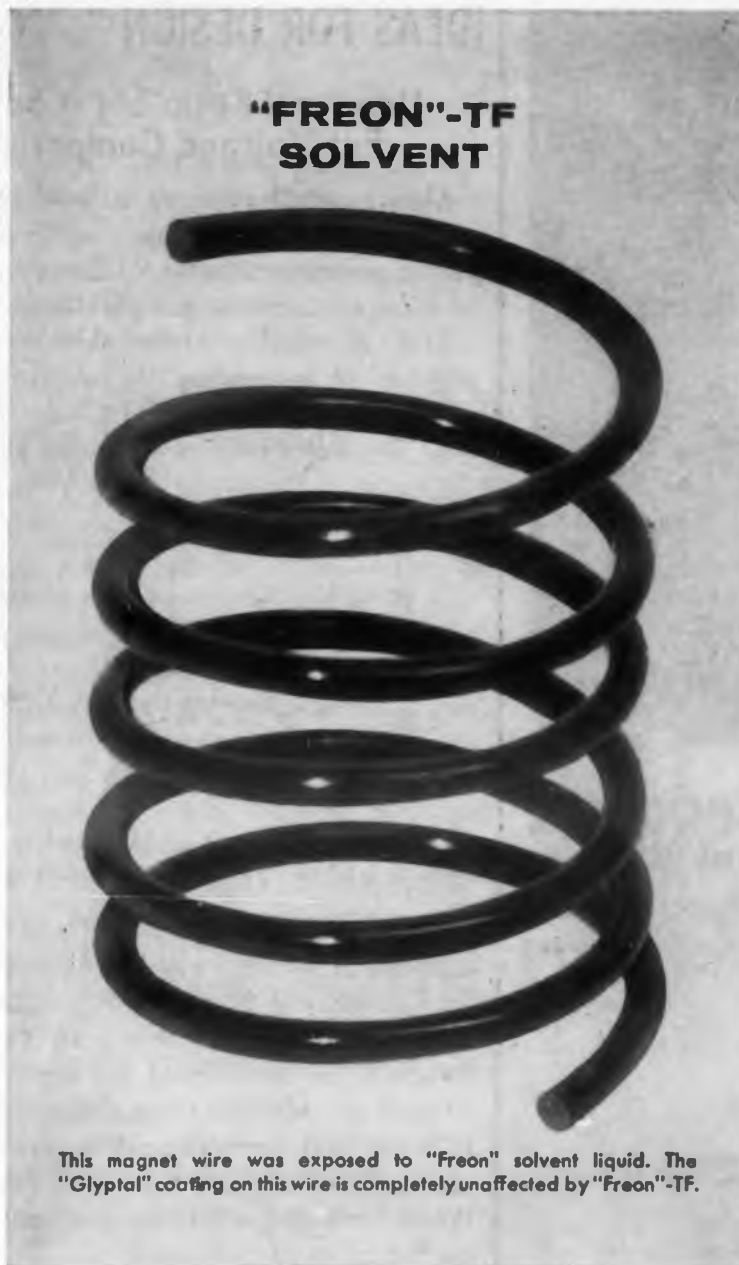
Frequently it is necessary to modulate a millivolt-level dc signal with a step function. This is done, for example, when determining the response of a system such as a floating input dc amplifier. Attempts to use a low frequency square wave generator usually result in the injection of extraneous ac pickup on the low level output leads.

The circuit shown generates repetitive step functions by shorting a portion of the voltage divider through relay contacts. The relay is driven by a free running multi-vibrator, operated from an isolated battery source. The constants indicated provided repetition rates from 0.1 pps to about 8 pps by varying the bias resistor,  $R_1$ , while the 100-ohm pot,  $R_2$ , controls the depth of modulation. With zero modulation,  $E_o$  is approximately 1/100 of the monitored voltage  $V$ , and has a maximum value of 60 mv.

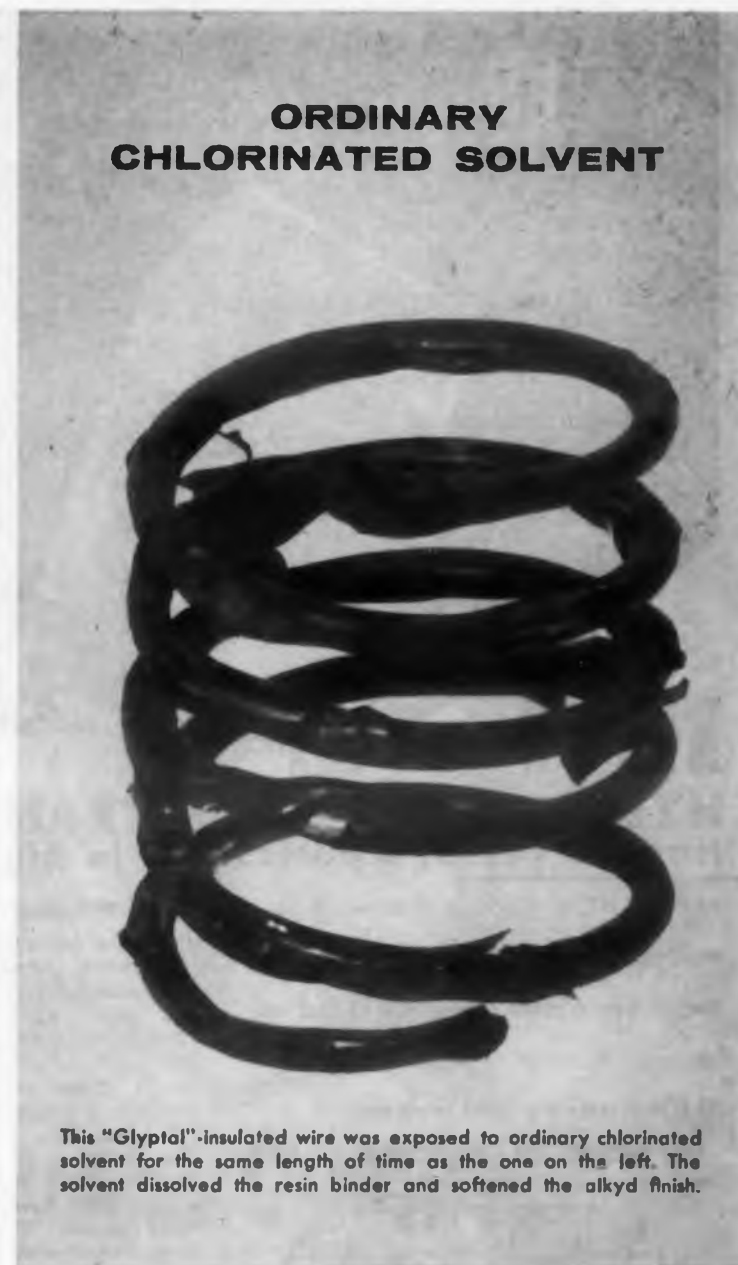


Driven by a free-running multivibrator, the pulse relay step-modulates a low-level dc signal.

John Porter, President, Portronics, Inc., Tarrytown, Calif.



This magnet wire was exposed to "Freon" solvent liquid. The "Glyptal" coating on this wire is completely unaffected by "Freon"-TF.



This "Glyptal"-insulated wire was exposed to ordinary chlorinated solvent for the same length of time as the one on the left. The solvent dissolved the resin binder and softened the alkyd finish.

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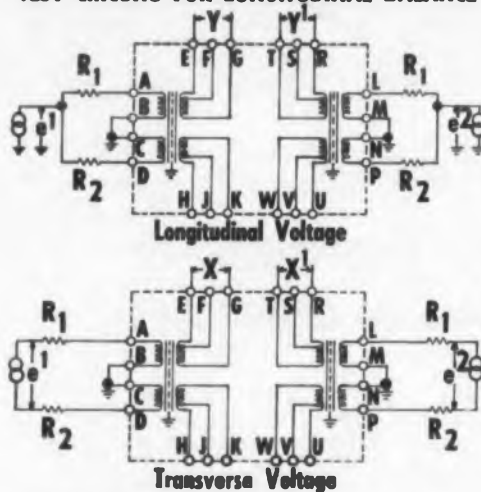


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**APPLICATION:** Used to isolate an unwanted signal in certain parts of a circuit yet allows the same signal to be used in other parts of the circuit.

HI-0394 may be used inverted.

### TEST CIRCUITS FOR LONGITUDINAL BALANCE



$$R_1 = R_2 \pm 0.1\% \quad R_1 + R_2 = 600 \pm 0.5\% \text{ OHMS}$$

$$\text{Longitudinal Balance} = 20 \text{ LOG } \frac{X}{Y} \text{ db} \text{ \& } 20 \text{ LOG } \frac{X}{Y} \text{ db}$$

### Specifications—Model HI-0394

Designed in Accordance with EIA Standard RS-174 and/or Mil-T-27A Class R Grade 4

#### Frequency Response:

200 cps  $\pm$  0.5 db

1000 cps  $\pm$  0.0 db

4000 cps  $\pm$  0.5 db

Power: + 15 dbm max

Impedance: 600/600:600

#### DC Resistance:

Total Primary 60 ohms max

Total Secondary 60 ohms max

#### Maximum Rated Current:

Total Primary 60 ma DC

Total Secondary 60 ma DC

Ambient Temperature:  $-10^\circ\text{C}$  to  $+65^\circ\text{C}$

Duty Cycle: Continuous

#### Total Harmonic Distortion:

$< 0.2\%$  @ + 15 dbm Input

Frequency Response, Distortion, Input & Output

Impedances, and Trans-Hybrid Loss Requirements Are Met with up to 60 ma DC

Electro-static Shielding—Internally Grounded To Case

Size:  $2\frac{1}{4} \times 2\frac{1}{4} \times 3\frac{3}{8}$  Including Terminals

Trans-Hybrid Loss: Total Primary

@ 60 ma DC

Nominal Input

200 cps  $> 25$  db  $> 25$  db

300 cps  $> 32$  db  $> 30$  db

800 cps  $> 40$  db  $> 30$  db

1000 cps  $> 45$  db  $> 30$  db

2000 cps  $> 43$  db  $> 30$  db

2800 cps  $> 43$  db  $> 30$  db

3600 cps  $> 37$  db  $> 24$  db

4000 cps  $> 20$  db  $> 20$  db

Longitudinal Balance:

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35 db 2000-4000 cps

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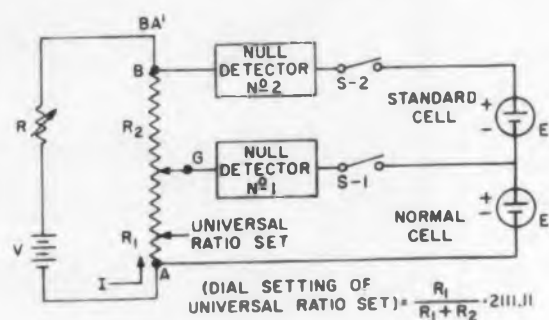
CIRCLE 146 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Universal Ratio Set is Suitable For Voltage Comparisons

The universal ratio set is well known for its accuracy and convenience as a device for comparing precision resistors.<sup>(1)</sup> However, it can also be used as a voltage comparator.

This use may be illustrated by considering the problem of comparing the electromotive force of a standard cell to that of a normal (reference) cell. The test circuit is shown in Fig. 1. As the



A universal ratio set can be used to compare voltages as well as to compare precision resistors.

first step, switch S-2 is closed and rheostat R is adjusted to produce a null at detector 2. At null, the voltage drop from A to B is equal to the sum of the electromotive forces of the two cells. Switch S-1 is then closed and the universal ratio set dials are adjusted to provide a null at detector 1. At this null, the voltage drop across R1 is equal to E1, the electromotive force of the normal cell. When both null conditions are satisfied, the following ratios are obtained:

$$\frac{E_2}{E_1} = \frac{IR_2}{IR_1}, \quad \frac{E_2}{E_1} = \frac{R_2}{R_1}$$

It is clear that

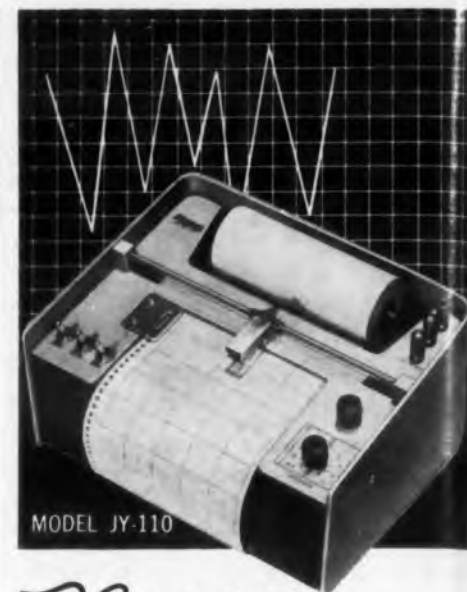
$$E_2 = \left(\frac{R_2}{R_1}\right) E_1$$

and the accuracy of the comparison is dependent on the accuracy of ratio of the ratio set. Commercially available ratio sets provide ratio accuracies from 0.01 to 0.005 per cent. Care must be taken when wiring and operating the test circuit to minimize errors due to thermal emf's.

### Double-Substitution Technique for Greater Accuracy

If greater accuracy is desired, together with greater freedom from the effects of thermal electromotive forces, a double-substitution technique can be used. A first reading is taken as described above. A second reading is then taken with the cell positions interchanged. The value of the un-

(1) J. L. Thomas, "Precision Resistors and Their Measurement," NBS Circular 470, Oct. 8, 1948.



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GENERAL DYNAMICS

CIRC E 148 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • August 17, 1960

known  $E_2$  is then determined from:

$$E_2 = \left(\frac{D_2}{D_1}\right) E_1$$

where  $D_1$  is the first dial setting and  $D_2$  is the second dial setting. Accuracies of a few parts per million are possible with this method.

Kenneth H. ReCorr, Radio Corporation of America, Electron Tube Div., Harrison, N.J.

### Inexpensive Time-Delay Drop-Out Uses a Thermal Relay

In searching for an inexpensive time-delay drop-out of several seconds delay time, it was found that none were available for under twenty dollars. However, a time-delay pull-in of the thermal type was available for a little over two dollars, with a single pole, single throw contact, either normally open or normally closed. Using the circuits shown, delay drop-outs were built which cost less than ten dollars each. The circuit of Fig. 1 uses three relays with a simple two-wire on-off switch for control. If there is no objection to using a three-wire double-throw control switch, the circuit of Fig. 2 permits even greater economy by eliminating one relay. In this circuit the control switch must also be capable of switching on the load current. In either circuit the delay time is nominally equal to the pull-in delay time of the thermal relay.

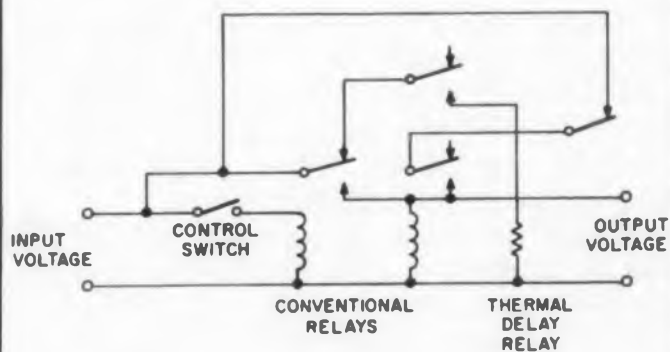


Fig. 1. After several seconds thermal relay opens causing conventional relays to drop out as well.

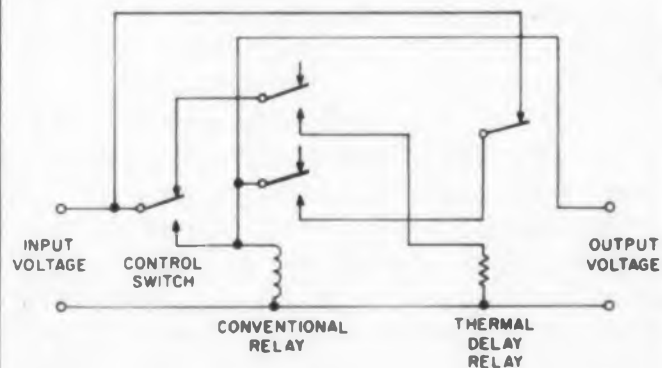


Fig. 2. Three-wire, double-throw control switch allows one relay to be eliminated.

R. A. Jacobs, Jr., Cranbury, N. J.



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CIRCLE 903 ON CAREER INQUIRY FORM, PAGE 163

## IDEAS FOR DESIGN

### Desk Calculator Evaluates Standard Polynomial Expression

By re-arranging the terms of the polynomial  $a_n x^n + a_{n-1} x^{n-1} + a_{n-2} x^{n-2} \dots + a_0$ , a desk calculator can be used to evaluate the expression for any given value of the variable  $x = x_0$ . The procedure can also be applied to binary-to-decimal number conversion.

The polynomial is rearranged as follows: Multiply  $x_0$  by the first coefficient  $a_n$  and add the next coefficient  $a_{n-1}$  to the product. Continue this procedure, developing the series of terms  $a_n x_0 + a_{n-1}; a_n x_0^2 + a_{n-1} x_0 + a_{n-2}; a_n x_0^3 + a_{n-1} x_0^2 + \dots$ ; etc., until the point is reached where the constant term is added. This result is the evaluated polynomial.

This method is a "natural" for use on a desk calculator. It is also the basis for the "double-dabble" system of translating binary to decimal numbers. Thus, if  $x_0$  is 2 and the coefficients  $a_i$  are the binary digits 1 and 0, we have a simple desk calculator procedure for binary to decimal conversion.

Jesse Roth, Project Engineer, Kearfott Co., Clifton, N. J.

### Feedback Amplifier Generates Narrow Pulses

Operating from a 6-v supply and a 5-mc sine wave input, the transistor pulse generator, Fig. 1, supplies 18 nsec, 1.5-v pulses into a 56-ohm load. The simple circuit is a compact source of narrow pulses for applications where square-shaped trigger-pulses are not essential.

Although the schematic resembles that of a blocking oscillator, the generator is basically an amplifier biased to prevent conduction in the absence of an input signal. Positive feedback is provided by the transformer, which has a reasonably high  $Q$  at a frequency of about five times the

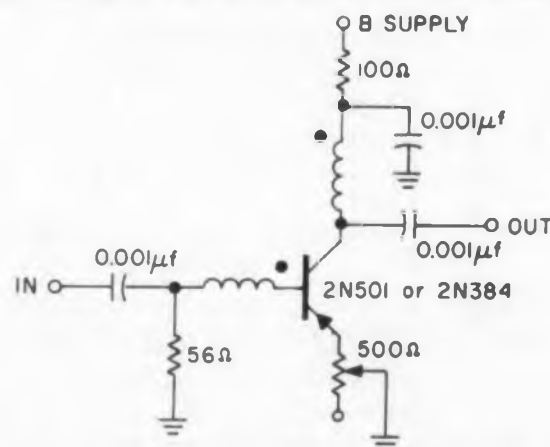


Fig. 1. Although its schematic is similar to that of a blocking oscillator, the pulse generator differs considerably in operation and in output waveform.



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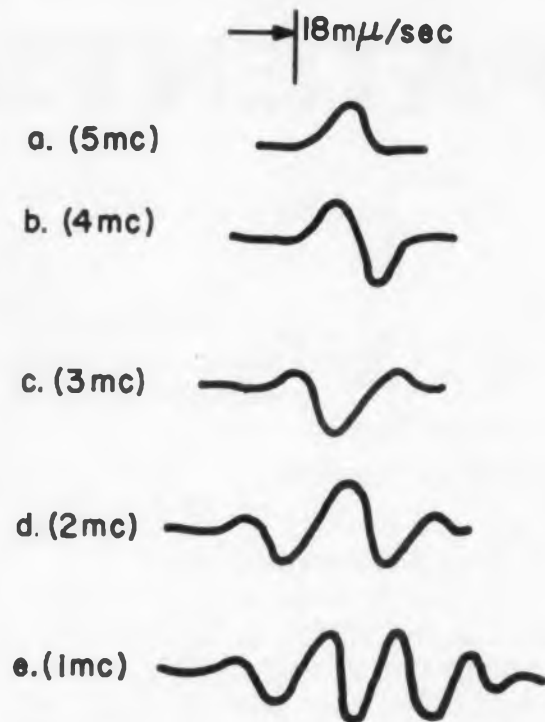


Fig. 2. Output waveforms for various input frequencies.

pulse repetition frequency of the input signal. The transformer band-pass is designed to allow about a 90-per-cent build-up during the time the input brings the transistor out of cut-off. The transformers used 3/8 in. diam Ferramic G cores obtained from the General Ceramics Corp. The winding ratios were varied somewhat with specific applications but generally ran one or two turns on the base winding and five to seven turns on the collector. Tertiary windings and the various output methods common to blocking oscillators worked well.

With the circuit biased well into cut-off, and the excursion of the drive signal only slightly above the value needed to bring the stage out of cut-off, the output is divided into a narrow pulse. The rise time of the transformer is such that the first cycle of oscillation is of very low amplitude. By the time the transformer output has built up to 90 per cent, the input signal is removed, and decay begins. This provides outputs of the form shown in Fig. 2, where the drive frequency is progressively decreased, being 5 mc for (a) and 1 mc for (e).

When feeding a 5-ohm load, the output pulse width increased to 38 nsec and the peak-to-peak voltage was only 0.9 v. It was also found that two generators in cascade produced the 18-nsec pulse width from an input as low as 5 kc.

Winding the transformer was simple because of the few turns required. Encapsulated, the unit was about the size of a dime. Leads were positioned by inserting them in a transistor socket during the encapsulation. This permitted the circuit to be plugged into a conventional transistor socket.

Richard Allen, Engineer, The Martin Co., Baltimore, Md.

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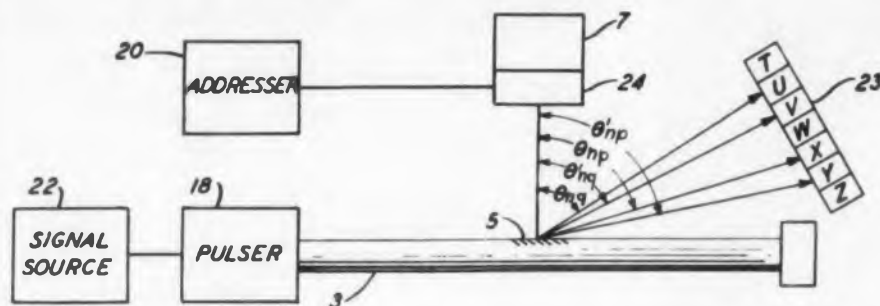
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# PATENTS

Benjamin Bernstein



### Light Beam Apparatus

Patent No. 2,936,381. T. R. Long. (Assigned to Bell Telephone Labs)

An elastic acoustic impulse transmission member marked with a diffraction grating is used as a signal delay and distribution device.

Signal source 22 controls pulser 18 which impulses rod 3. The rod is scribed with a grating 5. A light source 7 illuminates the grating and the reflected line spectra are bent, according to the instantaneous grating constant, and directed to the cells of receiver 23. Addresser 20 gates the light source so that only designated cells of the receiver are illuminated.

### Microwave Suppressed Carrier Modulator

Patent No. 2,936,429. H. L. Robinson, C. I. Smith and M. M. Zinet (Assigned to Sperry Rand Corp).

This single sideband generator produces either sideband while suppressing the carrier at least 40 db by conventional microwave techniques.

The first hybrid junction 3 contains a crystal M in one arm where the carrier mixes with the modulating signal. A variable mismatch 4 in the other arm adjusts the phase so that the carrier is attenuated in the load 5. In the second hybrid junction, sliding shorts 7 and 8 provide variable mismatches.

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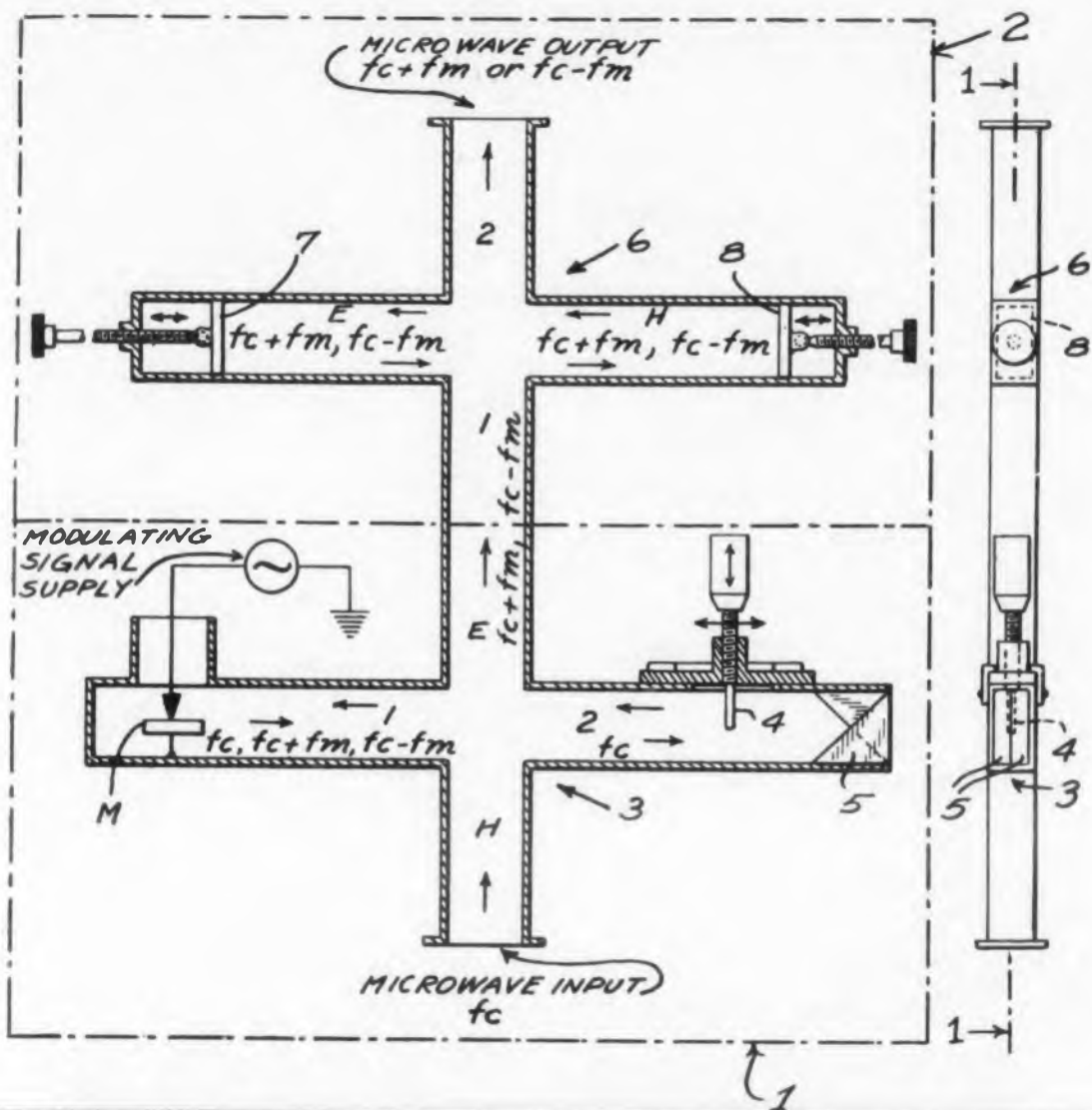
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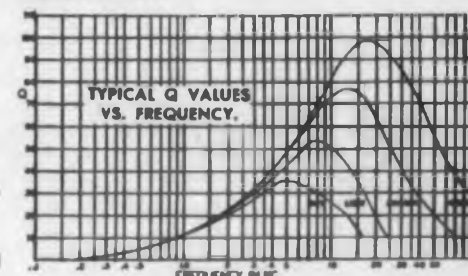


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**FREQUENCY:** 100 KC (Other frequencies available).  
**OUTPUT:** One volt into 5000 ohms.  
**POWER:** 28 volt DC (Other voltages available). Built-in Zener voltage regulator.  
**VIBRATION:** 5 G's — 5 to 2000 cycles — less than one part per million.  
**ALTITUDE-HUMIDITY:** Available sealed or unsealed.  
**TEMPERATURE RANGE:** From -55°C to +85°C.  
**DIMENSIONS:** 1-3/4" x 1-1/2" x 4-3/4" H. Weight: 6 1/4 Ounces

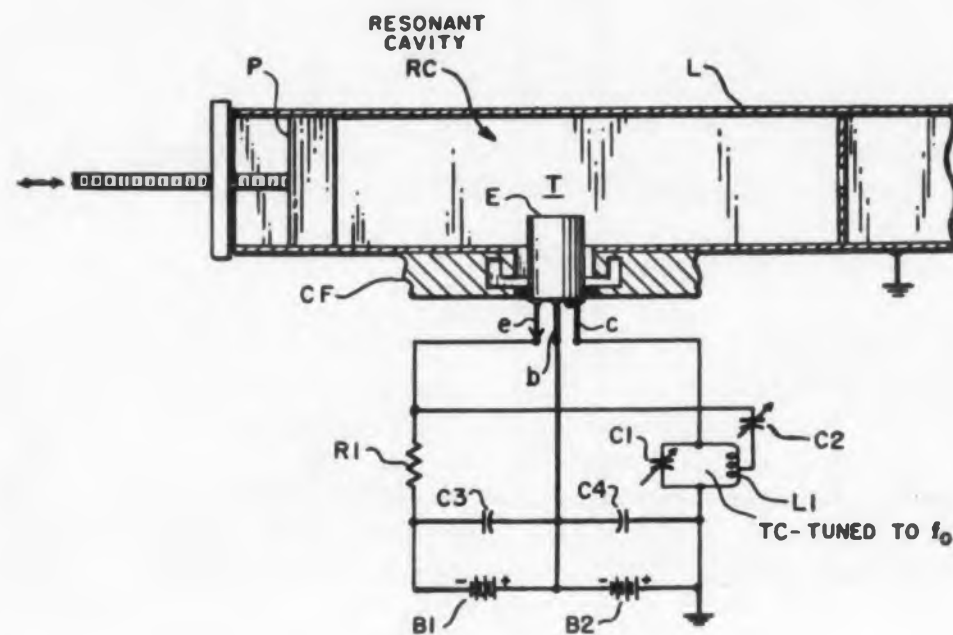
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Sandwich, Illinois



CIRCLE 157 ON READER-SERVICE CARD

## PATENTS



### High Frequency Harmonic Generator Employing Transistor

Patent No. 2,926,312. F. A. Brand and George E. Hambleton. (Assigned to USA)

A harmonic generator is obtained by

coupling a transistor oscillator to a tunable cavity. For reasons not precisely known, the arrangement detects and amplifies the tenth harmonic of the oscillator circuit.

Transistor *T* and tank circuit  $L_1C_1$

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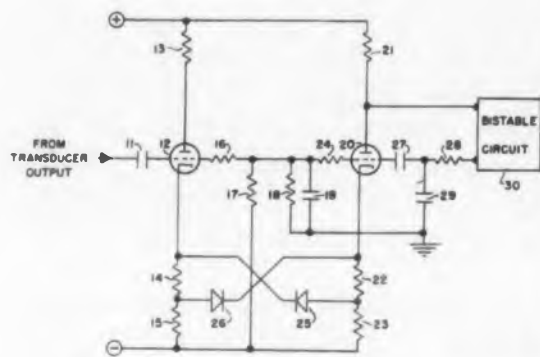
form a Hartley oscillator operating approximately at 300 mc. The transistor is enclosed in a metal container which projects into the cavity. The tenth harmonic of the fundamental frequency is detected by tuning the cavity with the plunger P.

#### Noise Rejection Circuit

Patent No. 2,925,494. R. French and R. F. Casey (Assigned to Monroe Calculating Machine Co.)

In a digital magnetic recording playback system, the switching circuit is made immune to noise by dynamic control of the bias on a pass tube. A simple analysis of the circuit shows that the transducer pulses are integrated on the grid of pass tube 20 which is simultaneously controlled by the setting of the bistable circuit. Triode 12 is a cathode follower which connects to voltage divider resistors 22 and 23 through diodes 25 and 26. Thus

if the cathode of triode 12 is more positive than the cathode of the pass tube, diode 26 conducts. This makes the pass tube insensitive to small positive going inputs. Similarly, the circuit is insensitive to small negative input changes since diode 25 will conduct to cancel the negative voltage applied to the grid of triode



20. The circuit will therefore switch only when large signal amplitudes are present. (See patent No. 2,929,029 Amplitude Discriminative Amplifier, R. F. Casey.)



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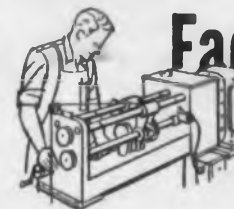
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## BOOKS

### Progress in Semiconductors, Vol. 4

A. F. Gibson, F. A. Kroger, R. E. Burgess, editors; John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N.Y., 291 pp, \$10.50.

Planned to be issued semiannually, these volumes contain a number of topics taken from the entire field of semiconductors. Although most articles give an assessment of the present state of knowledge in the field, articles dealing with original work are also presented.

### Units, Dimensions, and Dimensionless Numbers

D. C. Ipsen, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 236 pp, \$6.50.

A reference text in the area of dimensional analysis, the book provides a

thorough discussion of the concept of units and dimensions. Appropriate as a supplementary text in engineering courses, this is also a suitable reference for research and design engineers. It contains insight into the pitfalls of dimensional analysis and includes remarks about the validity and usefulness of this method.

The topics are first discussed from a theoretical point of view; problems and examples are presented at the end of most chapters.

### Advances in Aeronautical Sciences, Vol. I and II

Th. von Karman, Pergamon Press Inc., 122 E. 55th St., New York 22, N.Y., 1144 pp, \$30.00 (set).

These volumes contain the outstand-

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ing papers presented at the First International Congress for the Aeronautical Sciences held in Madrid on September 8 to 13, 1958. The papers reproduced here are in the original languages.

Topics covered that are written in English include: telecommand and navigation; mass transfer cooling in high-speed aircraft; hypersonic heat transfer; safety in automatic flight control; and telecontrol and telemetry for pilotless aircraft.

#### Fixed and Variable Capacitors

G. W. A. Drummer and Harold M. Nordenberg, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 288 pp, \$10.00.

Written from the standpoint of the user, this book contains information necessary in selecting capacitors and using them effectively. It covers the following types of units: paper, mica, ceramic, glass, vitreous enamel, electrolytic, air, vacuum, and glass-filled. Data is also provided on general purpose, precision, transmitter, trimmer, and special types of variable capacitors.

Chapters contain information on such

topics as electronic part development; capacitor characteristics; selection, and techniques of measurement; modern experimental units; faults liable to occur in capacitors; and the future of capacitor design.

Charts, graphs, and illustrations are used throughout.

An index and a complete bibliography are also included.

#### Basics of Gyroscopes Vols. I and II

Carl Machover, John F. Rider Publisher, Inc., 116 W. 14th St., New York, N.Y. 112 pp (Vol. I), 120 pp (Vol. II), Vol. I: \$3.30 (soft cover); Vol. II: \$3.30 (soft cover); Vols. I and II: \$6.60 (soft cover), \$7.75 (cloth binding).

Directed to the layman, the student, or the engineer who is not a specialist, this text presents and disengages the basic principles of gyroscopes. Beginning with an explanation of the fundamentals of gyroscope operation, the author goes on to cover commercial types of gyroscopes, including those in missile use. Easily understood illustrations are used. Mathematics is kept to a minimum.

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# Automatic Gain Control Gives Increased Amplifier Reliability

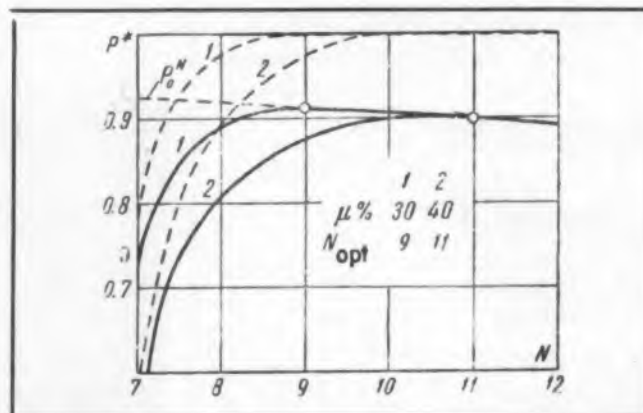
**N**EGATIVE feedback in an amplifier circuit helps maintain reliability despite gradual deterioration component of electrical properties, and reduces the probability of gradual failure. Although the feedback circuit adds components, its effect on the over-all reliability of the system is frequently more important than the possibility of sudden failure of an element.

The mathematical relations given below make it possible to estimate quantitatively the influence of automatic gain control on the reliability of an amplifier. These relations illustrate the method of investigating feedback as a means of increasing reliability. The also can be applied to other feedback devices.

## Reliability of Amplifier Without AGC

First consider an  $n$ -stage amplifier without agc. Assume the gain of any stage ( $k$ ) is a random quantity  $\xi_k$ , that the random quantities  $\xi_k$  are independent of each other and that their distribution functions are identical for all amplifier stages. The over-all gain  $\eta_n$  is also a random quantity, equal to the product of the  $\xi_k$ 's.

Assume the permissible gain deviations of the amplifier from the nominal value  $k$  are  $k(1 - \delta_1)$  and  $k(1 + \delta_2)$ . Also, let  $(1 - p_0)$  be the probability of a sudden failure of one amplifier stage. Because the reliability of the amplifier ( $p$ ) is equal to the probability of a combination of two



**Reliability of amplifier** with agc vs. number of stages for typical amplifier. Curves for two values of the parameter  $\mu$  are shown in solid lines. Dotted curves show factors of Eq. 8.

events—the absence of sudden failure and the maintenance of the electric parameters within the described limits—then

$$p = p_0 P \{k(1 - \delta_1) \leq \eta_n < k(1 + \delta_2)\} \quad (1)$$

where  $P \{\cdot\}$  is the *a posteriori* probability of satisfying the inequalities contained in the bracket in the absence of sudden failure.

Determining the distribution function of the gain  $\eta_n$  as the product of random quantities entails considerable mathematical difficulty. But, if we use instead of  $\eta_n$  its logarithm, then at sufficiently large  $n$  we can use the Lyapunov theorem on the normalization of the sum of independent random quantities, and assume that  $\ln \eta_n$  has a normal distribution. The average

value of  $a_n$  and the dispersion  $\sigma_n^2$  of this random quantity are

$$a_n = na_1, \quad \sigma_n^2 = n\sigma_1^2 \quad (2)$$

Consequently, at sufficiently large  $n$

$$P \{k(1 - \delta_1) \leq \eta_n < k(1 + \delta_2)\} \\ = P \{\ln k(1 - \delta_1) \leq \ln \eta_n < \ln k(1 + \delta_2)\} \sim \\ \sim \frac{1}{\sqrt{2\pi n\sigma_1^2}} \int_{\ln k(1 - \delta_1)}^{\ln k(1 + \delta_2)} e^{-\frac{(x - na_1)^2}{2n\sigma_1^2}} dx \quad (3)$$

Inserting Eq. 3 into Eq. 1 gives an expression for the reliability of an amplifier without agc

$$p = p_0^n \left\{ F \left[ \frac{\ln k(1 - \delta_1) - na_1}{\sigma_1 \sqrt{n}} \right] - F \left[ \frac{\ln k(1 + \delta_2) - na_1}{\sigma_1 \sqrt{n}} \right] \right\} \quad (4)$$

$$F(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-x^2/2} dx$$

## Reliability of Amplifier With AGC

The introduction of negative feedback in the form of agc reduces the amplifier gain. Therefore the number of amplifier stages should be increased to  $N > \eta$ . Denote by  $\eta_N^*$  the over-all gain in the presence of agc and assume the permissible deviations of the gain from nominal are the same, that is:

$$k(1 - \delta_1) \leq \eta_N^* \leq k(1 + \delta_2) \quad (5)$$

Let  $\beta$  be the coefficient of negative feedback. Then:

$$\eta_N^* = \frac{\eta_N}{\beta\eta_N + 1} \quad (6)$$

where  $\eta_N$  is the gain of the  $N$ -stage amplifier without agc.

Choosing the coefficient  $\beta$  to satisfy the condition  $\beta k = 1(1 + \delta_2)$ , gives, from Eqs. 5 and 6, a one-sided condition imposed on  $\eta_N$

$$\eta_N \geq k \frac{(1 - \delta_1)(1 + \delta_2)}{\delta_1 + \delta_2} = k\delta \quad (7)$$

Direct determination of the probability distribution function  $\eta_N^*$  is very complicated. But, because Eq. 5 is equivalent to Eq. 7, we again can use the theorem on the normalization of the sum of random quantities. That is:

$$\ln \eta_N = \sum_{k=1}^N \ln \xi_k$$

For sufficiently large  $N$  the following expression

for the reliability of an amplifier with agc holds:

$$\begin{aligned}
 p^* &= p_0^N p_f P \{k(1-\delta_1) \leq \eta_N^* < k(1+\delta_2)\} \\
 &= p_0^N p_f P \{\ln \eta_N^* > \ln k\delta\} \\
 &\sim p_0^N p_f \left[ 1 - F \left( \frac{\ln k\delta - Na_1}{\sigma_1 \sqrt{N}} \right) \right] \quad (8)
 \end{aligned}$$

where  $p_f$  is the reliability of the feedback devices.

The right half of Eq. 8 consists of two factors. The first diminishes monotonically, and the second increases monotonically with increasing  $N$ . Consequently, there exists an optimum number of stages  $N_{opt}$ , at which the reliability of the amplifier with agc is maximum. Thus, there is a range of values for  $N$  within which an increase in the number of stages (unreliable elements) leads to an increase in the reliability of the amplifier (a system of elements). This is the effect of the feedback on the reliability of the amplifier.

For a quantitative estimate of the effect of agc on the reliability of an amplifier, let us consider the following example: Let  $k = 2 \times 10^4$ ,  $\delta_1 = \delta_2 = 0.25$ ,  $p_0 = 0.99$ , and  $p_f = 1$ , and let the average value of the gain of one stage  $b = 5.4$ . Let the distribution of the gain be symmetrical and triangular.

In this case the number of amplifier stages without agc is  $n = 6$ , and the number of amplifier stages with agc is  $N > 6$ . Fig. 1 shows curves for the dependence of the reliability  $p^*$  of the amplifier with agc and the number of stages  $N$  at two fixed values of  $\mu$  (where  $\mu = \sigma/b$  and  $\sigma^2$  is the dispersion of the gain of one stage)\*. The dotted lines show each of the factors contained in Eq. 8. The optimum number of stages, corresponding to the maximum reliability, varies with the dispersion of the value for the amplification of one stage.

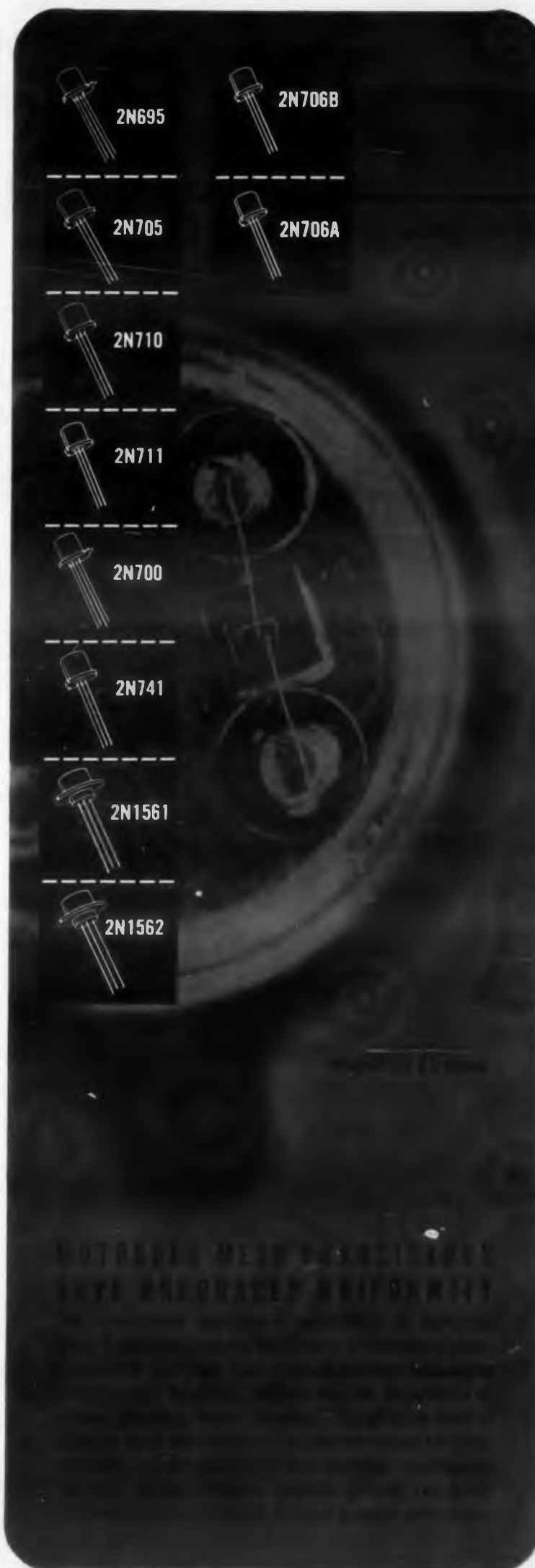
For an amplifier without agc, the probability of the gain falling outside the permissible limits is close to zero. Then, if the relative mean squared spread  $\mu$  of the gain of one stage does not exceed 5 per cent this probability exceeds 0.9.

Translated from News of the Academy of Sciences, Division of Technical Sciences, Automation and Power, No. 2, March-April, 1960, pp 208-209.

\*Although the variable  $N$  assumes only integral values, the function  $p^*(N)$  is shown in the figure, for the sake of clarity, in the form of a continuous curve.

#### References

1. N. G. Bruyevich, *Reliability and Accuracy of Automatic Production*, News of the Academy of Science, Div., Tech., Sci., Automation and Power, No. 4, 1969.
2. B. Levin, *Methods of Investigating the Reliability and Spare-Part Supply for Electronic Systems*, Problems of Radioelectronics, Series XL, 1969, No. 1.
3. I. S. Gonorovskiy, *Principles of Radio Engineering*, Svyaz'izdat, 1957.



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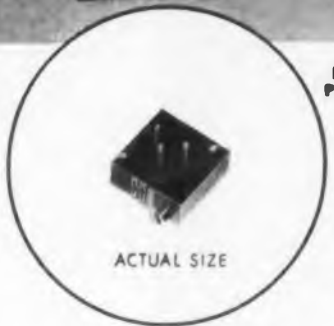


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## GERMAN ABSTRACTS

E. Brenner

# Sampling Accessory Converts LF Sc

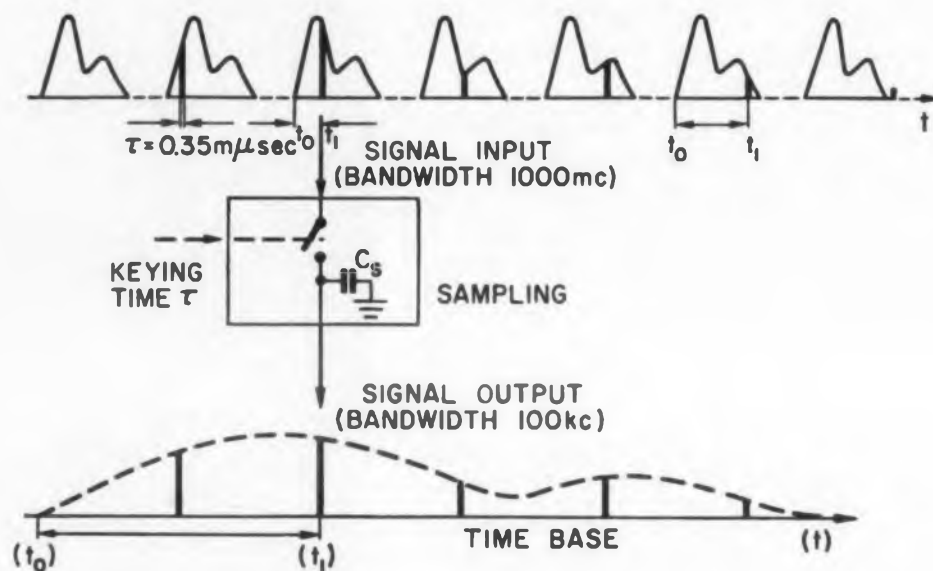


Fig. 1. Samples of the periodic signal are taken once during each sweep at progressively longer time intervals.

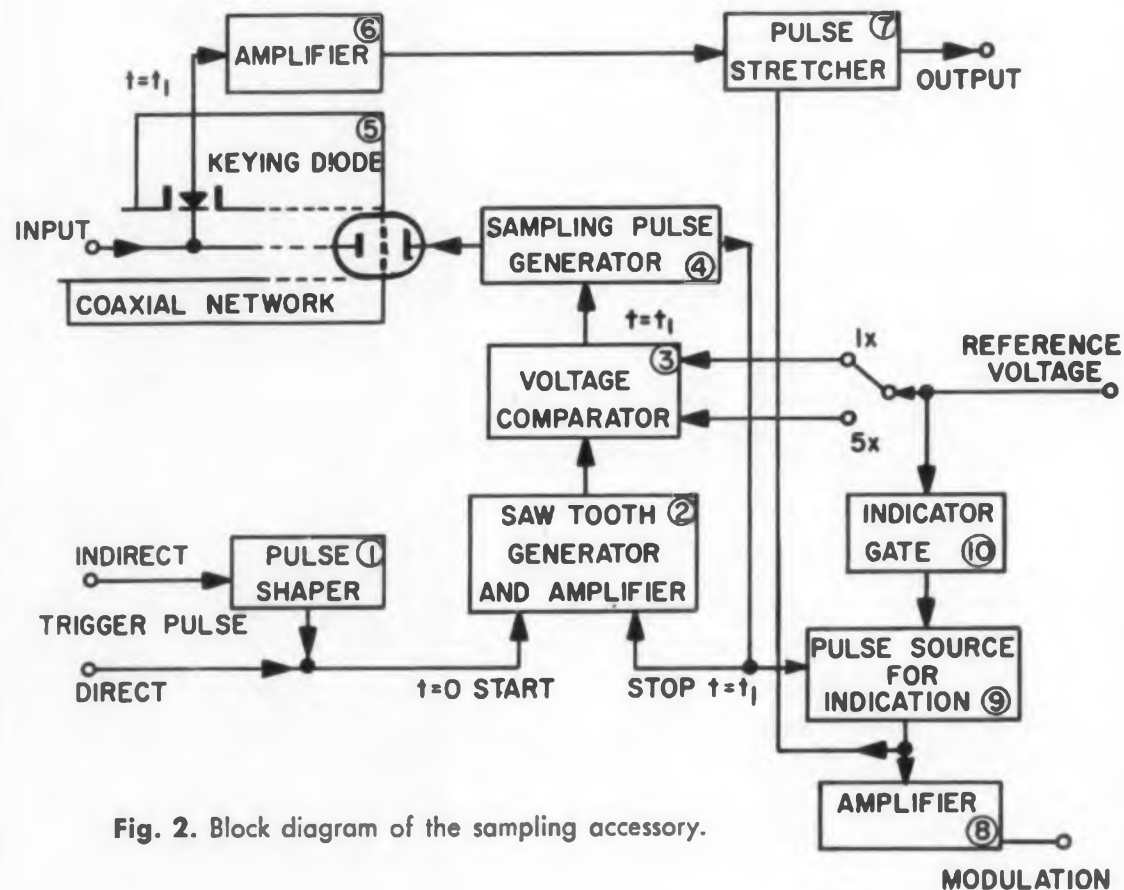


Fig. 2. Block diagram of the sampling accessory.

## Scope for HF Use

DESIGNED for high frequency pulse work, a signal sampling circuit was developed as an accessory to a "low" frequency crt, such as the Tektronix 535.

In general, conventional oscilloscope amplifiers are limited in rise time resolution because of deflection sensitivity requirements. The use of signal sampling\* makes it possible to combine high sensitivity with high resolution (0.35  $\mu$ sec).

Fig. 1 shows the basic principle of the sampling procedure; (it is a fundamental assumption that the signal is recurrent or periodic). The signal is sampled once during each sweep at progressively longer time intervals ( $t_1 - t_0$ ). This interval is controlled by comparing a linear sawtooth voltage with a reference. The resolution is determined by the time interval during which the sampling "switch" is closed ( $\tau$ ).

The block diagram of the sampler, developed by IBM, Zurich, is shown in Fig. 2. A trigger pulse initiates a sawtooth (2) with minimum time delay (0.04  $\mu$ sec). The pulse shaper (1) allows the device to be used with small or slow-rise triggers. This stage also serves as a frequency divider when the pulse repetition rate exceeds the sawtooths. The comparator (3) determines the sampling instant and controls the sampling pulse generator (4). The latter also returns the sweep to rest. A coaxial network shapes the keying pulse to its proper amplitude and duration. The keyed signal is passed by the sampling diode (5), is amplified (6) and stretched (7) and is made available at the output terminals.

Since only the peak values of the sample pulse contains information, the pulse generator (9) synchronously controls the beam intensity. The indicator gate (10) is used to block the pulse generator (9) when the comparator voltage is outside the sawtooth range.

The original paper also includes circuit details of the sawtooth source and comparator (2, 3), the sampling pulse generator (4) and the sampling diode circuit.

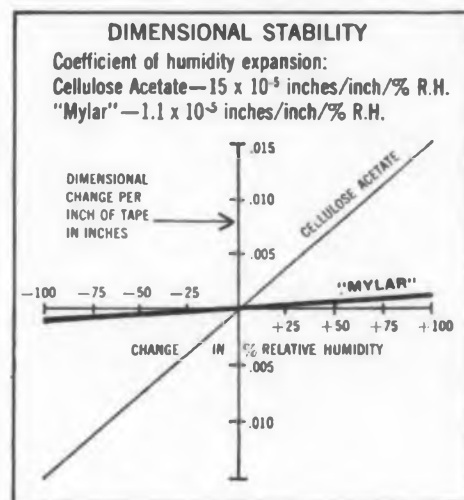
Abstracted from an article by H. P. Louis *Elektronische Rundschau*, Vol. 14, No. 4, April 1960, pp 137-144.

\*Sampling oscilloscopes for statistically varying pulses." R. Sugarman, *Rev. Sci. Instr.* Vol. 28 (1957) p 933-938.

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CHART NO. 1

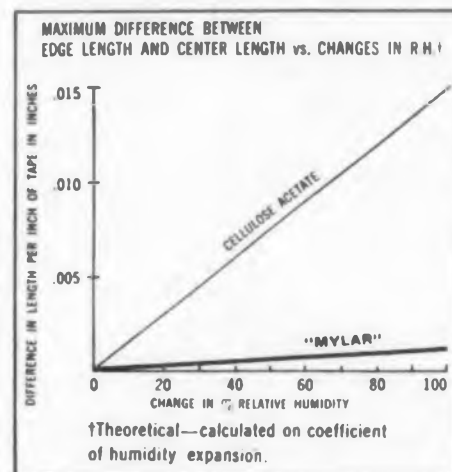


### Less signal dropout.

Chart 1 shows that dimensional change in "Mylar" with humidity change is negligible compared to acetate. This exceptional stability prevents tape shrinking, swelling or cupping that could result in shifting of

tracks or loss of contact with the recording or playback head. Possibility of signal dropout or garbled or weak signals are minimized and reliability of recorded data is assured.

CHART NO. 2



### Fewer garbled signals.

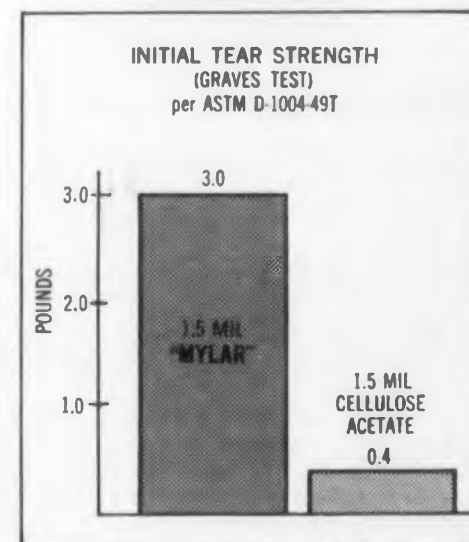
If magnetic tape picks up or loses moisture unequally across the tape width there will be a difference in length between the edges and center. Chart 2 compares this effect for "Mylar" and cellulose acetate tapes. Because "Mylar" is virtually non-hygroscopic there is no dimensional difference between edges and center to cause poor registration of timing across adjacent tracks on the tape.

### Less tape breakage.

Since most breaks start as edge nicks,

the high initial tear strength of "Mylar" reduces chance of breakage and subsequent failure to record critical information. Chart 3 compares initial tear strength of "Mylar" and acetate. In addition, "Mylar" has the highest tensile strength of any instrumentation tape base. And "Mylar" does not lose its toughness with age, repeated playbacks or storage because it has no plasticizer to dry out.

CHART NO. 3



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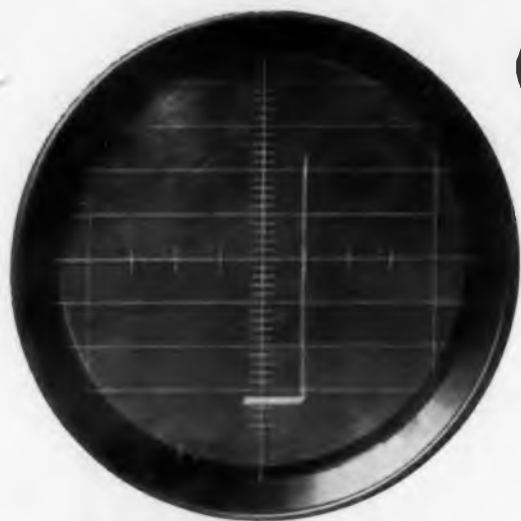
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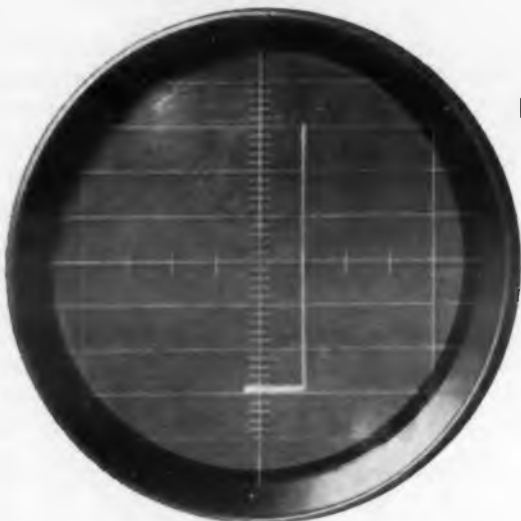
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(before)

Reverse leakage tracing before immersion in  $H_2O_2$ .



(after)

Reverse leakage tracing after immersion in  $H_2O_2$ , dried without washing (virtually no change).

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**ELECTRONIC DESIGN  
DIGEST**  
of recent papers and literature

## Disposable Equipment Modules Give Economical Operation

**A**IRCRAFT electronics equipment modules may be used and then discarded without raising procurement, support and maintenance costs.

According to the National Bureau of Standards, aircraft equipment built of expendable four-to-eight tube assemblies—or modules—would cost no more than similar equipment built with repairable four-to-eight-tube modules.

Current design trends indicate increasing use of modular construction for compact, intricate electronic equipment. It is possible, however, to use expendable assemblies that are not modular in form.

Nevertheless, because of the advantages possible through the use of standardized modules, it is probable that future equipment will make increasing use of modular construction.

The advantages of expendable modules are as follows:

**1—Improved reliability of electronic equipment.** Because they are expendable, the modules may be imbedded in plastic or hermetically sealed. Data on how much reliability is improved by these means is not available. However, many manufacturers feel that these protective methods definitely improve reliability.

Doing away with the repair procedure also improves reliability because repairs increase the wearout of electronic assemblies. Also, there is the possibility that replacement parts may be inferior to original parts.

**2—Improved systems maintenance.** Because most Air Force technicians are in the service for a comparatively short time, it is not possible or practical to train them to be fully capable of piece-part repair and simultaneously be fully capable of maintaining entire systems, such as navigation and communication systems.

Under disposal-at-failure maintenance training for piece-part repair could be considerably reduced and more time spent on the operation and maintenance of systems.

**3—Reduction of number of spare parts.** A typical four-tube module contains about 40 parts that must be supported with spares, if the module is to be repaired when it fails. Expendable modules, however, need be supported only with spare modules. Thus, the paperwork associated with inventories would be drastically reduced.

**4—Reduction of number of specifications.** At present, a specification is required for each part in an assembly. Use of expendable modules would require only a single specification for the complete module.

**5—Better storage possibilities.** Because expendable modules would probably be imbedded or hermetically sealed, they should withstand long storage periods with little or no added protection. They also should require less storage volume than that needed for repairable assemblies and spare parts. These parts often are stored in individual containers that are larger than the assemblies in which they ultimately are used.

**6—Usefulness under emergency conditions.** Disposal-at-failure maintenance realistically provides for wartime conditions. Piece-part repair of an assembly probably could not be made at the front-line level, and time would not allow such repairs to be made at higher maintenance levels. Hence, defective assemblies probably would be discarded even though they were intended to be repaired.

Several objections to the use of expendable modules have been made. These objections and the authors' arguments against them follow:

**1—Technical skills in the military would decline.** It is true that a knowledge of parts and

ELECTRONIC DESIGN • August 17, 1960

circuit details would be less important than it is now. However, the skills required to locate faults in electronic systems would still be necessary. Present maintenance activities are generally so understaffed that a reduction in skilled personnel is unlikely. Expendable modules would enable the present maintenance organization to handle increased future workloads through more efficient use of manpower.

**2—Carrying spare modules would burden the supply system.** Because only complete modules would be supplied, rather than the present multitude of components, the supply system should be capable of handling sufficient spare modules. The reliability of standard expendable modules should be ascertained prior to acceptance by the military. Knowing reliability, the number of spare modules necessary for a given period of time could be calculated.

**3—Data on the failure of parts could not be obtained.** Failure data on the parts in expendable modules could possibly be obtained by returning some of the modules that failed to the manufacturer for evaluation.

At the same time, excellent failure data for the modules themselves could be obtained. This data would make it easier to predict and improve the reliability of modular equipment.

**4—The cost of supplying expendable spare modules would be excessive.** The study shows there is an optimum module size (between four and eight tubes) for which the costs incurred with expendable modules are equal to those incurred with repairable modules.

The optimum module size for aircraft equipment was determined by calculations involving the reliability of the parts that make up the module, the cost of the parts, and the following assumptions: a program life of five years; the rate at which equipment is retired taken as 1.5 per cent; spares are procured for the period in which the equipment could reasonably be expected to be operated; spares could be shifted to any loca-

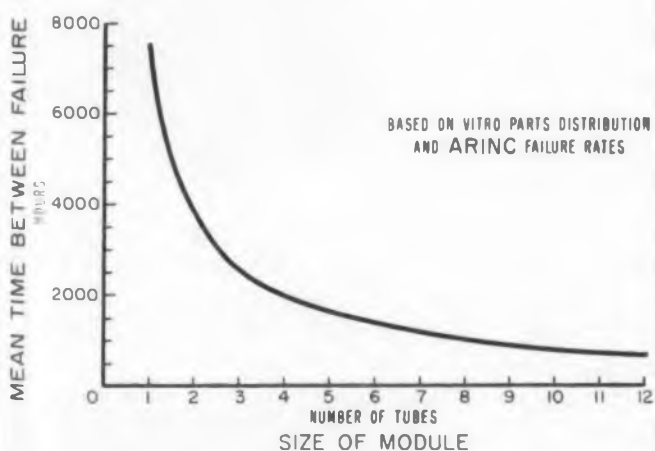


Fig. 1. Mean life of a typical module vs module size. Data for reliability calculations were obtained from Vito Laboratories and Aeronautical Radio, Inc.

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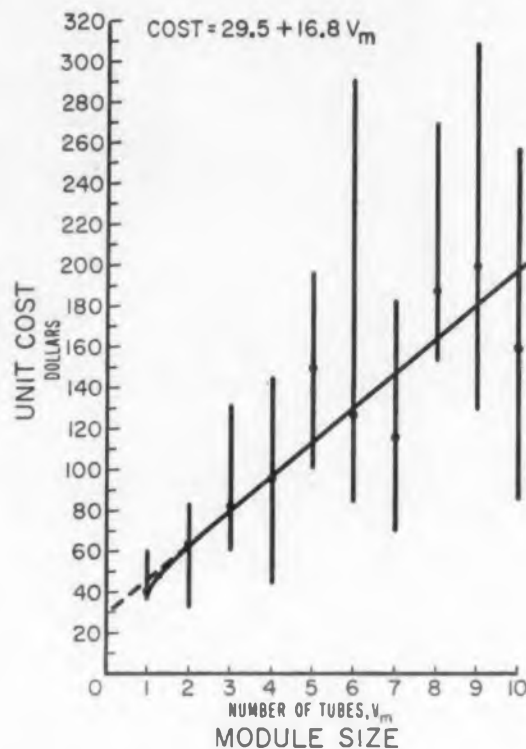
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## DIGEST



**Fig. 2.** Unit cost of modules vs module size. Vertical bars show range of assembly costs. Heavy dots show average costs for each range. The curve drawn is linear, least-squares fit of average costs.

tion at any time; there is a 95 per cent probability that sufficient spares are procured over the program life.

Curves of module reliability vs module size and module cost vs module size are shown in Figs. 1 and 2.

Contrary to popular belief, it would probably be poor practice to attain expendable modular design by simply subdividing the equipment into modules that cost less to replace than to repair.

The reason is that in taking into account the number and cost of the spares probably needed over the program life, the curve of total procurement cost vs. size of module becomes fairly flat in the range between one- and eight-tube module sizes.

Therefore, because considerable latitude exists with respect to costs, other criteria should be considered. These are:

**1—Ease of maintenance.** Because this is the primary goal in the subdivision of equipment, it should be given the most weight in design decisions. From this viewpoint, larger modules are most advantageous. It is, for example, considerably less difficult to locate a defective six- or eight-tube module than to locate a one- or two-tube module.

**2—Modification.** Often, after sets and spares



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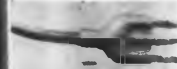
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have been procured, the sets must be modified. Because modification of the modules would be difficult or impossible, it would be desirable to work, in these situations, with smaller circuit blocks—or smaller modules.

The weight given to the modification factor depends on the knowledge and experience that goes into the equipment design. When advanced equipment requiring an extension of the technical art is being considered, the modification factor should be given considerable weight. When considering equipment of mature design this factor may be given less weight.

3—Logistics. The types of spares increase rapidly as the module size is reduced. This would suggest larger modules to minimize the number of items controlled by supply. However, as the module size increases, the storage volume for required spares goes up rapidly. This suggests smaller modules to reduce storage problems.

However, in front-line operation, the volume of spares is the most serious consideration, and smaller modules would be most desirable.

The smallest module, of course, would be the one-tube assembly. However, a design using one-tube modules is more difficult to develop and has lower reliability, poorer maintainability and larger size and weight than one using larger modules. These disadvantages, it is concluded, probably outweigh the benefits that would come from universal use of standard one-tube modules.

It is on the basis of these criteria that the authors rule out one- to three-tube modules along with modules of more than eight tubes.

The study also decides that four- to eight-tube modules are optimum by a comparison of costs of maintaining systems constructed of repairable and expendable modules.

The approach was to concentrate on areas in which costs of the two systems were known to differ—principally, the handling and disposition of a defective assembly after it has been located. The report concludes that the costs of repairable and expendable systems are so nearly equal that cost may effectively be eliminated as a criterion. Detailed examination of the expendable case led to the assertion that four- to eight-tube assemblies are optimum.

In the future, however, it is likely that designs will lean to larger modules because reliabilities are improving, program lives are becoming shorter and equipment attrition rates are constantly decreasing.

*Digested from Expendable Modules as Bases for Disposal-at-Failure Maintenance by R. O. Stone, P. Meissner and K. M. Schwartz, all of the National Bureau of Standards, Washington D.C. Copies of the report cost \$2.25 each, and may be purchased from the Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C.*

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## YOUR CAREER NEWS AND NOTES

A division of the Hughes Aircraft Co. takes inventory of the hidden talents of its staff members.

The company's Ground Systems Group reports that the assembled data, called the Professional Register, are used for promotional and reassignment purposes and for preparing sales proposals and contract bids.

Hughes says that better use of staff talents has helped to ease its shortage of engineers.

"We have recognized for some time," the company says, "that the greatest source of scientific and engineering talent lies within the know-how of our existing technical staff. The engineering staff numbers approximately 1,000 scientists and engineers who have sorely needed supplementary talents necessary for expansion and growth."

The information submitted to the company is kept confidential and is stored in data-processing equipment.

When is an engineer a scientist? Too often, according to the Engineers Joint Council, New York.

The council placed advertisements recently in "Editor & Publisher," a magazine for the newspaper profession, explaining the difference between engineers and scientists. "Scientists make it known, but engineers make it work," was the theme of the advertising campaign to distinguish, for the communications media, the engineer from the scientist.

The advertisements carried such titles as "Let's Get Clear on What Engineers Do," "Just Who's Firing Those Missiles," and "Say Engineer When You Mean Engineer."

According to Engineer, the newly founded newspaper published by the EJC, the campaign reached millions of persons when news media decided that the engineers' efforts to explain themselves rated coverage.

The Datex Corp., Monrovia, Calif., is paying its engineers to write material that will not be used by the company.

The aim is to encourage its personnel to produce articles for professional and trade magazines. The author will receive \$100 from the company when his article is not published or the difference between \$100 and his fee if the article is published.

Authors must submit their work to a review board that includes the president of the company. Guides for writing were distributed by the company to its personnel.

Several Milwaukee companies are encouraging their engineers to take eight months off from work in the next two years to participate in a graduate program at Marquette University.

The university, in cooperation with the companies, will initiate the graduate cooperative program this Fall. The engineers selected to participate will spend one semester (four months) each year as full-time students. They will complete their thesis requirements during work periods.

The university also has requested the companies to allow certain senior staff members to accept appointments as research professors. In this capacity they would supervise the thesis work of engineers in their companies when it is done on the job.

Electrical engineers are more in demand than other engineering specialists, according to the University of Michigan Placement Office. The average monthly starting salary for electrical engineers is \$547, the university reports.

By a series of self-administered, self-scoring tests developed by General Electric and Deutsch and Shea, personnel consultants, young engineers can now determine for themselves their suitability for various fields of engineering.

The tests, developed over a six-month period by personnel men from Deutsch and Shea and by top-ranking working engineers in GE's Light Military Electronics Department, are for the exclusive use of the person interested in the field. Results are not communicated to GE or Deutsch and Shea. The multiple-choice questions are of a practical nature and directly concerned with work in the field rather than theory or textbook matters. Grades achieved can be compared with an interpretive scale based on performance of Light Military engineers at all experience levels.

So far, the tests cover the fields of radar, micro-waves, communications, and electronic packaging. There is a fifth, non-technical test on human relations, designed to demonstrate suitability for administration or technical contribution.

Each test consists of 30 to 40 questions and answers are bound into the last pages of each test pamphlet. When the test is finished, the last pages may be cut and the test scored. When the person taking the test has scored himself, he may compare the result with an interpretation on the facing page.

In the period of planning and pre-testing, GE engineers worked with Deutsch and Shea consultants to make sure each question was clear, concise—and fair. If questions were found to be misleading, too easy, or too hard, they were modified or thrown out.

Any qualified engineer holding a B.S. or advanced degree can receive copies of the tests by writing to Ron Bach, Light Military Electronics Dept., General Electric, French Road, Utica, N.Y. Only two tests are allowed to each person, so the engineer should state what fields he is interested in.

## ENGINEER-IMPROVEMENT COURSES AND SEMINARS

*Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.*

### One-Day Seminars

#### Industrial Education Institute Offers Two One-Day Seminars

The Industrial Education Institute will offer one-day seminars on "Reducing Costs in Drafting and Design Operations" during August. The seminar offers systems and procedures for reducing costs in every phase of drafting and design operation. Conducted by Don Fuller, Director, Drafting and Design Division, IEI, the seminar was developed for Drafting and Design Supervisors and Managers. The Seminar Schedule is as follows: Boston (Hotel Sheraton-Plaza), Aug. 15; New York (Hotel Park-Sheraton), Aug. 16; Philadelphia (Hotel Sheraton), Aug. 18; Chicago (Hotel Sheraton Towers), Aug. 23; Cleveland (Hotel Sheraton-Cleveland), Aug. 24; Cincinnati (Hotel Sheraton-Gibson), Aug. 26.

A one-day seminar on "More Effective Problem Solving In Engineering, Manufacturing, and Marketing," offered by the Industrial Education Institute and designed for technical specialists and supervisors opens in Montreal at the Hotel Sheraton-Mt. Royal on Aug. 15. The seminar will be conducted by A. L. Spivak, Senior Engineer, Aircraft Propulsion Dept., General Electric Co. and Instructor in GE's Creative Engineering Program. The seminar schedule is as follows: Boston (Hotel Sheraton-Plaza), Aug. 16; New York (Hotel Park-Sheraton), Aug. 17; Philadelphia (Hotel Sheraton), Aug. 18; Toronto (Hotel King-Edward Sheraton), Sept. 12; Detroit (Hotel Sheraton-Cadillac), Sept. 13; Chicago (Hotel Sheraton-Towers), Sept. 20; Cleveland (Hotel Pick-Carter), Sept. 21.

## PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

Aug. 26: Authors should submit titles and abstracts of proposed papers to A. M. Colgstron or R. C. Fletcher, Program Chairman, Bell Telephone Laboratories, Murray Hill, N.J., for Sixth Annual Conference on Magnetism and Magnetic Materials to be held in New York City, Nov. 14-17 at the New Yorker Hotel. Sponsored jointly by the American Institute of Electrical Engineers and the American Institute of Physics, in cooperation with the Office Research, the Institute Of Radio Engineers and the Metallurgical Society of the A.I.M.E.

Oct. 14: Deadline for 300-500 word abstracts and 50-word summaries for the 1961 International Solid-State Circuits Conference. The conference is scheduled for Feb. 15-17 at the University of Pennsylvania and the Sheraton Hotel, Philadelphia, Pa. Papers should deal with the following: advanced circuitry. Send to: Jerome J. Suran, Bldg. 3, Room 115, General Electric Co., Electronics Park, Syracuse, N.Y.

Oct. 14: Deadline for Reportial Session (submit for refereeing) for the 1960 Proceedings of the Conference on Magnetism and Magnetic Material. Contributed papers will be limited to a space equivalent to a page and one half of printed matter in the *Journal of Applied Physics*. Address inquiries to the Publications Committee.

Oct. 21: Deadline for abstracts and summaries for the Technical Program of the 1961 IRE National Convention to be held at the Waldorf-Astoria Hotel and New York Coliseum, New York, N.Y., on March 20-23, 1961. Prospective authors are requested to submit all of the following information: 100-word abstract in triplicate, title of paper, name and address; a 500-word summary in triplicate, title of paper, name and address. Indicate the technical field in which your paper falls. Original papers only will be considered; any necessary military or company clearance of paper is to be granted prior to submittal. Address all material to Dr. Gordon K. Teal, Chairman, 1961 Technical Program Committee, The Institute of Radio Engineers, Inc., 1 E. 79th St., New York 21, N.Y.

Oct. 28: Deadline for Regular Sessions (submit for refereeing) for the 1960 Proceedings of the Conference on Magnetism and Magnetic Material. Papers will be limited to a space equivalent to a page and one half. Abstracts submitted with the final manuscript must be brought up to date. Address inquiries to the Publications Committee.

# How Do You Meet a Challenge?



Delco Radio is doing it with TALENT and RESOURCES

We feel the challenge of new concepts in electronics and Solid State Physics can only be met by an intelligent application of outstanding abilities and resources.

To meet this challenge, Delco—over the years—has built up over one million square feet of modern manufacturing, laboratory and office facilities. Newest in the Delco complex is a 125,000 sq. ft. engineering and research facility now under construction in Kokomo, Ind., and scheduled for completion in 1961. In addition, Delco has available the extensive services of the General Motors Technical Center and field test facilities.

But physical resources are only half the answer. It took bold, imaginative talent to lead Delco to its present respected position in the electronics industry. Likewise, the challenge of the future requires a constant infusion of new ideas and new talent.

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### PHYSICISTS, CHEMISTS AND METALLURGISTS

For semiconductor device development. With experience in: semiconductor materials (to lead a program on metallurgical research of new semiconductor materials), semiconductor device encapsulation, alloying and diffusion, chemistry of semiconductor devices.

We're eager to find experienced personnel with a desire for a stimulating challenge and the abilities to fulfill this challenge. Responsible positions are available for those who qualify.

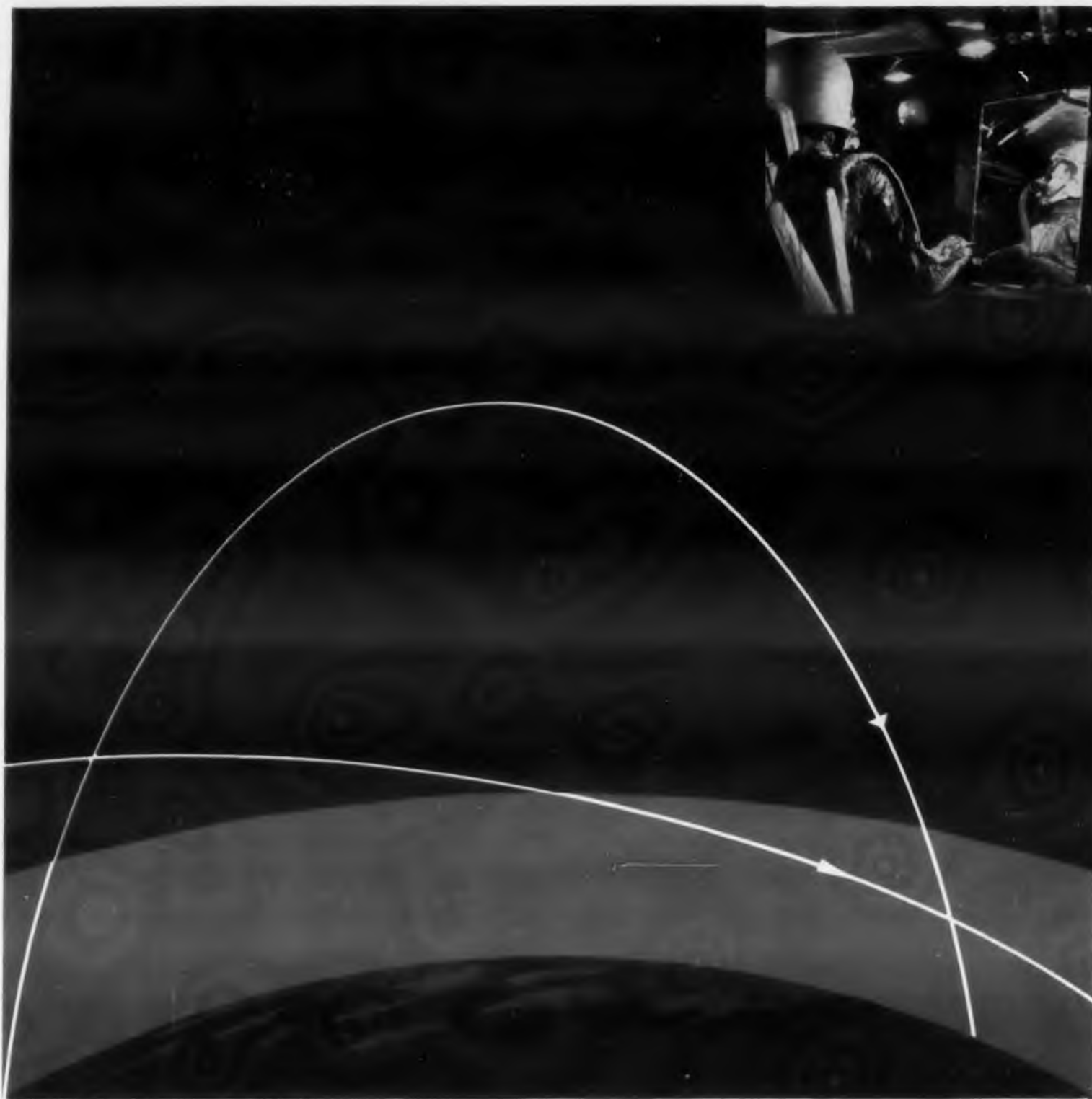
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## CAREER OPPORTUNITIES BROCHURES



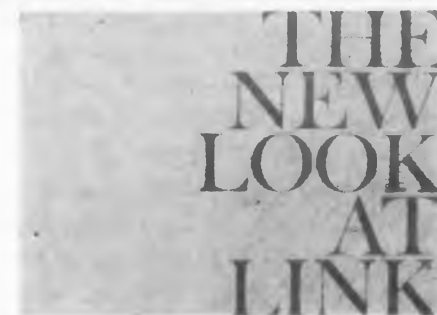
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The research, development, engineering, and manufacturing facilities at Zenith Radio Corp. are described and illustrated in a 36-page booklet. Beginning with an introduction on the firm's history, the booklet goes on to discuss the research laboratories in three solid-state areas: fundamental physics, semiconductors, and ceramics. The section on the engineering department covers the advanced development groups, the special products and military division, test and analysis facilities, and technical writing. Operations and facilities at subsidiary companies are also included.

Roy C. Orr, Zenith Radio Corp., Dept. ED, 6001 Dickens Ave., Chicago 39, Ill.

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"The New Look at Link" is a 6-page brochure designed to give prospective employees a thumbnail sketch of the products and opportunities in the Link Div. of General Precision, Inc. Located at Binghamton, N.Y., Palo Alto, Calif., and College Park, Md., Link is known for its work in flight simulation and training; however, it has taken on a "new look," namely expansion into other areas of electronics: automatic check-out, instrumentation and automation, visual and optical systems, and data processing.

In addition to a list of company benefits, the brochure outlines opportunities in engineering research and development, manufacturing, sales, and general administration.

Link Div., General Precision, Inc., Dept. ED, Binghamton, N.Y.

CIRCLE 881 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 17, 1960

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE**

USE BEFORE SEP. 28, 1960

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

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(Please print with a soft pencil or type.)

Name \_\_\_\_\_ Telephone \_\_\_\_\_

Home Address \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

Position Desired \_\_\_\_\_

*Educational History*

College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

*Employment History*

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience \_\_\_\_\_

Professional Societies \_\_\_\_\_

Published Articles \_\_\_\_\_

Minimum Salary Requirements (Optional) \_\_\_\_\_

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

**Advancement  
Your Goal?  
Use  
CONFIDENTIAL  
Action Form**

*ELECTRONIC DESIGN's* Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

*ELECTRONIC DESIGN* will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.

Your form is kept confidential and is processed only by this specialist.

The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.

All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!





## LACROSSE . . .

one of those rare accomplishments  
that makes a man proud he's an engineer

When Lacrosse split a 2 x 4 from 19 miles away, Martin-Orlando engineers knew they had a winner . . . a one-shot killer.

Lacrosse is the Army's most accurate surface-to-surface missile. It is fired from a highly mobile launcher somewhere in a rear area. A forward guidance team electronically picks up control of the missile in flight, and lays it dead on target.

Lacrosse is the kind of accomplishment engineers dream about. It came out of Martin-Orlando. So did Pershing, Bullpup, and Missile Master.

If you want success, recognition, and the feeling of being first with

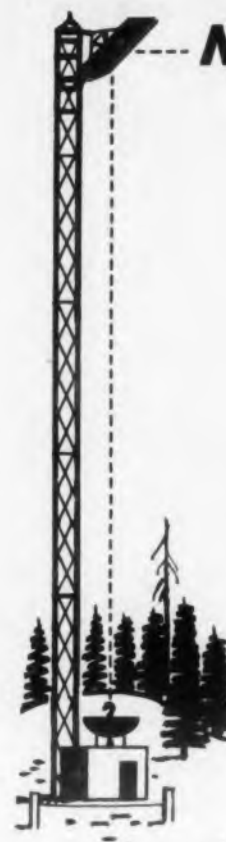
the most, we'd like to hear from you. Florida sunshine, sparkling lakes and palm trees aren't hard to take, either. Send resume to C. H. Lang, Director of Employment, The Martin Company, Orlando 16, Florida.

**CURRENT OPENINGS** for engineers in these areas: ground and airborne electronics • advance design • systems • aerodynamics • quality and test • reliability • electronic manufacturing

WORK IN THE CLIMATE OF ACHIEVEMENT

**MARTIN**  
ORLANDO

CIRCLE 906 ON CAREER INQUIRY FORM



## Microwave Engineers

Lenkurt Electric Co., a leading manufacturer of high performance carrier telephone, microwave and data transmission equipment, has immediate openings for senior microwave engineers in the development of microwave radio systems for multi-channel telephone service. Experience in video amplifier and broad band IF circuits, microwave test and design techniques and an understanding of semi-conductor applications in the microwave region is desirable. 5 - 10 years experience with a BS degree, or higher required. Top salary, liberal fringe benefits, including a stock purchase plan. Modern engineering labs located on the beautiful San Francisco peninsula.

Also other Communications Development Engineering positions available. For interested engineers, facilities in Vancouver, B.C., Canada, offer many opportunities.

Send resume or call collect LY 1-8461.

E. JACK SHANNAHAN  
Employment Manager

*Lenkurt* **ELECTRIC CO., INC.**   
San Carlos, California

a subsidiary of General Telephone & Electronics

CIRCLE 907 ON CAREER INQUIRY FORM

## ELECTRONICS JOBS

**\$6,000 to \$75,000**

**Still Go Begging**

Cadillac, the nation's largest executive & professional placement service represents every "Blue Chip" electronics firm in America—over 450 in all. Cadillac can offer you positions unequalled by any other firm.

### OUR SERVICE FREE OF CHARGE

Our completely confidential placement service is available to you absolutely **FREE OF CHARGE**. At Cadillac, Electronic Engineers don't receive the "fast shuffle" prevalent in small placement firms. The Electronics Division staff of eleven experienced counsellors is ready to serve you in analyzing the hundreds of available positions.

### FREE MONTHLY JOB SURVEY

Our monthly listing of top electronics positions is free to any Electronics Engineer. For your free survey, send your name and home address to:



J. L. Higgins, Manager  
Electronics Division

**Cadillac  
Associates, Inc.**

29 E. Madison Bldg. Chicago 2, Ill.  
Financial 6-9400

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**PAGES  
MISSING  
ARE NOT  
AVAILABLE**