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FEBRUARY 28, 1958

electronics

engineering edition

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DO-TS

Deci-Ouncer TransformerS

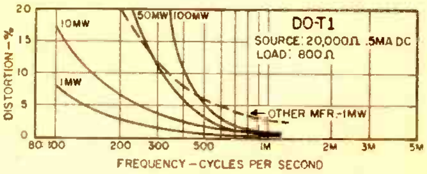
REVOLUTIONARY TRANSISTOR TRANSFORMERS

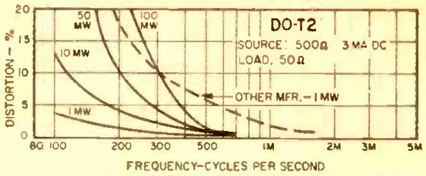
of unequalled power handling capacity and reliability

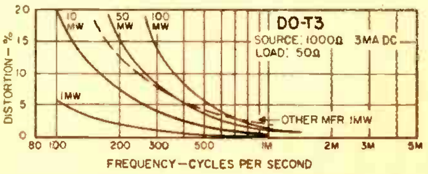
Hermetically Sealed to MIL-T-27A Specs.

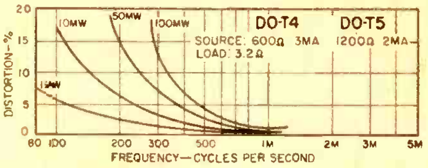
TYPICAL DO-T PERFORMANCE CURVES

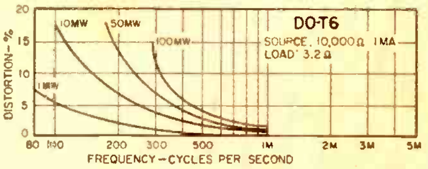
Power curves based on setting output power at 1 KC, then maintaining same input level over frequency range.

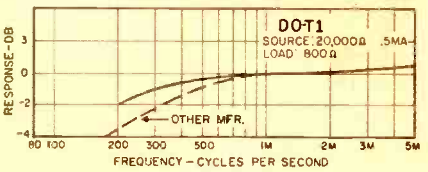


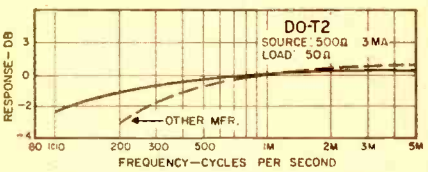


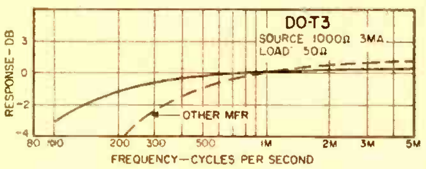


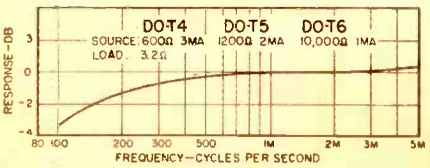












*DO-T units have been designed for transistor application only . . . not for vacuum tube service. **Pats. Pending

Conventional miniaturized transistor transformers have inherently poor electrical characteristics, perform with insufficient reliability and are woefully inadequate for many applications. The radical design of the new UTC DO-T transistor transformers** provides unprecedented power handling capacity and reliability, coupled with extremely small size. Twenty-five stock types cover virtually every transistor application*. Special types can be made to order.

High Power Rating . . . up to 100 times greater.

Excellent Response . . . twice as good at low end.

Low Distortion . . . reduced 80%.

High Efficiency . . . up to 30% better.

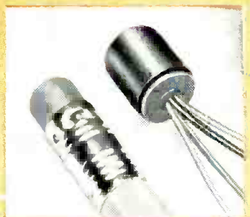
Moisture Proof . . . hermetically sealed to MIL-T-27A.

Rugged . . . completely cased.

Anchored Leads . . . will withstand 10 pound pull test.

Printed Circuit Use . . . (solder melting) plastic insulated leads.

ACTUAL SIZE



DO-T CASE Dia. . . . 5/16"
Length . . 13/32"
Weight . . 1/10th oz.

Type No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res.	Level Mw.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	50
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	100
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	100
DO-T4	TF4RX17YY	Output	600	3	3.2	60	100
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	100
DO-T6	TF4RX13YY	Output	10,000	1	3.2	1000	100
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500	25
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC				630	
DO-T9	TF4RX13YY	Output or driver	10,000 12,500	1 1	500 CT 600 CT	800	100
DO-T10	TF4RX13YY	Driver	10,000 12,500	1 1	1200 CT 1500 CT	800	100
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	100
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11	500
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20	500
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43	500
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51	500
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71	500
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108	500
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505	200
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	500
DO-T20	TF4RX17YY	Output or matching to line	500 CT	5.5	600	31	500
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	500
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	500
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	100
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500	25
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	100

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

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electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31 • NO. 9 • FEBRUARY 28, 1958

ISSUE AT A GLANCE

DIGEST CONTINUED ON NEXT PAGE

DIGEST (continued)

electronics

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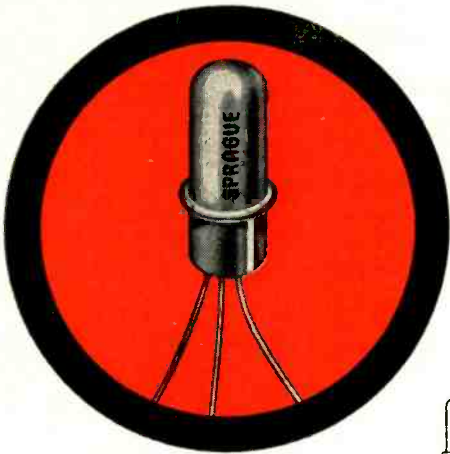
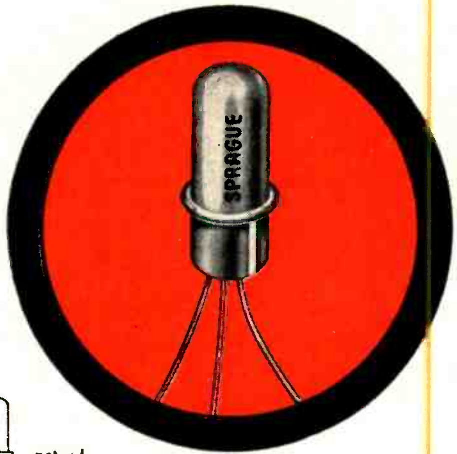
Member ABP and ABC

2N344/SB101
for Medium Gain Amplifiers

	Min.	Typ.	Max.
hfe	11	23	83
fmax	30	45	—





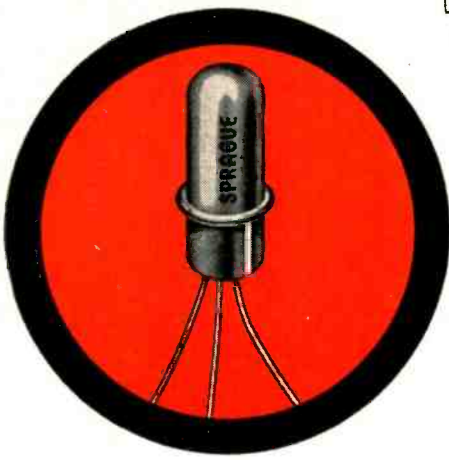
2N345/SB102
for High Gain Amplifiers

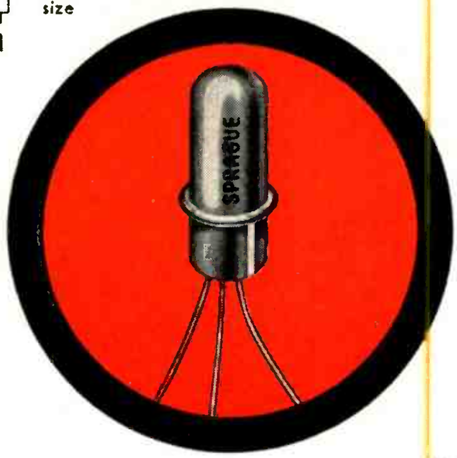
	Min.	Typ.	Max.
hfe	25	40	110
fmax	30	45	—

actual size

2N346/SB103
for High Frequency Oscillators

	Min.	Typ.	Max.
hfe	10	—	—
fmax	60	90	—





2N240/SB5122
for Computer Switching

	Min.	Max.
hfe	16	—
fmax	30	—
T_s	—	80

IN VOLUME PRODUCTION *Now!*

For general high frequency applications, and for high speed computer switching circuits, design around Sprague surface barrier transistors. They are available now in production quantities from a completely new, scrupulously clean plant, built from the ground up especially to make high quality semi-conductor products.

The four transistor types shown are the most popular. Orders for these units are shipped promptly. What's more, surface barrier transistors are reasonably priced. High quality and excellent electrical characteristics make them an economical solution to many difficult circuit requirements.

Sprague surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type number are manufactured to the same specifications and are fully interchangeable. You have *two* sources of supply when you use surface barrier transistors!

WRITE FOR COMPLETE ENGINEERING DATA SHEETS ON THE TYPES IN WHICH YOU ARE INTERESTED. ADDRESS REQUEST TO THE TECHNICAL LITERATURE SECTION, SPRAGUE ELECTRIC CO., 35 MARSHALL ST., NORTH ADAMS, MASS.

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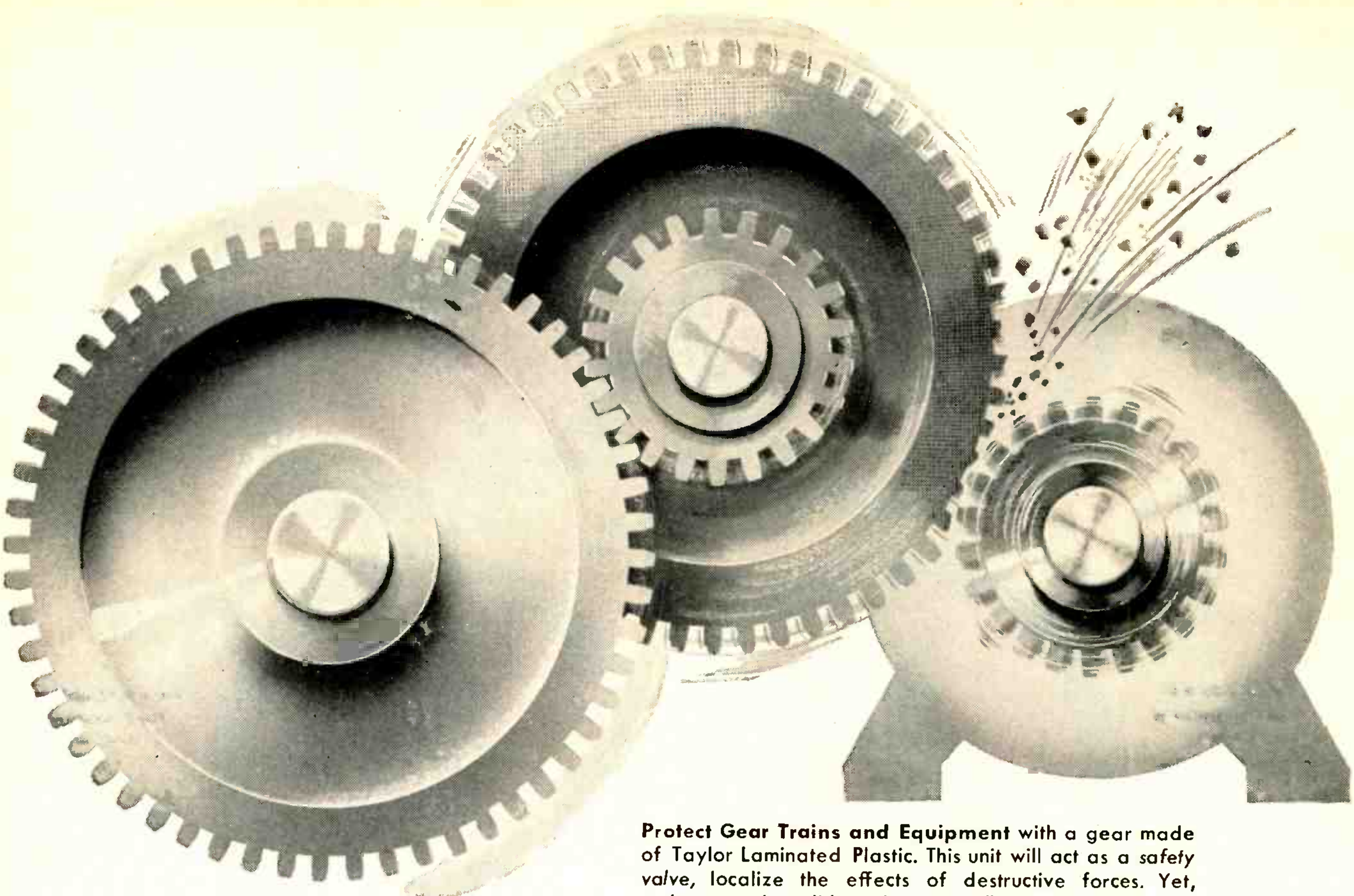

Protect Gear Trains and Equipment with a gear made of Taylor Laminated Plastic. This unit will act as a *safety valve*, localize the effects of destructive forces. Yet, under normal conditions, the gear will outwear metal ones.

Put a safety valve in your gear train

A gear made of Taylor Laminated Plastic Silent Gear Stock will localize damage due to destructive stresses, yet outwear metal under normal operating conditions

What gives when gears jam—the power train, the equipment they are in, or a single easy-to-replace gear? It can be the single gear when you install one made of Taylor Laminated Plastic Silent Gear Stock as a *safety valve*. This gear will localize the destructive forces and can even disintegrate—but the other gears in the train, and the equipment, will be fully protected. Yet it can outwear the metal ones.

Taylor Laminated Plastic Silent Gear Stock is made in several grades. Each has physical and mechanical properties that make it particularly adaptable to such application as gears, cams, pulleys, pinions, flat springs, and bearings.

Look into the advantages of Taylor Fibre Co. and its facilities for producing laminated plastics in mechanical, electrical and combination grades and parts fabricated from them. At your disposal will be engineering assistance and integrated operations at both plants—Norristown, Pa., and La Verne, Calif. Contact TAYLOR FIBRE CO., Norristown 40, Pa., for complete information.

TAYLOR
Laminated Plastics
Vulcanized Fibre

PHYSICAL PROPERTIES

Taylor grade	Water Absorption 24 hr. immersion (% max.)		Specific Gravity	Cu. in. per lb.	Rockwell Hardness	Heat Resistance (max.)	
	1/8 in.	1/2 in.				Continuous use (°F)	Intermittent use (°F)
C	2.5	1.2	1.35	20.5	M-103	200-225	225-250
L	1.6	0.90	1.35	20.5	M-105	200-225	225-250
LLL	1.6	0.90	1.32	21.0	M-105	200-225	225-250

MECHANICAL PROPERTIES

Taylor grade	Flexural Strength Flatwise (psi min.)		Tensile Strength (psi min.)		Compressive Strength (psi min.)	Izod Impact Strength Edgewise (ft./in. notch min.)	
	Length-wise	Cross-wise	Length-wise	Cross-wise	Flat-wise	Length-wise	Cross-wise
C	17,000	16,000	10,000	8,500	37,000	2.10	1.90
L	15,000	14,000	14,000	10,000	35,000	1.35	1.10
LLL	20,000	19,000	13,500	11,500	37,000	1.45	1.35

Typical Physical and Mechanical Properties of Taylor Laminated Plastics used in the fabrication of gears, cams, pinions, pulleys and bearings

PHENOLIC-MELAMINE-SILICONE-EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

new

Frequency Changer
for WIDE RANGE of FREQUENCIES...EXCELLENT REGULATION ...LOW DISTORTION

This NEW FCR100—latest addition to the Sorensen line of Frequency Changers—supplies a frequency range from 45 to 2000 cycles with exceedingly good wave form, and matches the other Sorensen Frequency Changers in uniformly excellent performance.
The low output harmonic distortion, with consistently reliable regulation of frequency *and* voltage, makes each of these Frequency Changers ideal for critical applications.
Let your Sorensen representative supply you with full details on these Frequency Changers—with or without filters.
Or write directly to headquarters for technical data.

FCR100

FCR250

FCR100
Input Freq.: 45-65 cps
Output Freq.: 45-2000 cps
Out. Freq. Regulation: ±1% or ±0.01% with suitable external standard
Load Range: 0 to 100 VA.
Input Voltage: 105 to 125 VAC
Output Voltage: 115 nominal VAC
Harmonic Distortion: 1% maximum
$530.— in cabinet.

FCR250
Input Freq.: 45-65 cps
Output Freq.: 320-1000 cps
Freq. Reg.: ±1.0%; or ±0.01% with optional internal frequency standard
Load Range: 0 to 250 VA (500 VA at 400 and 800 cps)
Voltage Input & Output: 105 to 125 VAC
Voltage Reg.: ±1%
Harmonic Distortion: 5% typically
$990.— in cabinet.

Note: This distortion value can be reduced to 3% from 350 to 450 cps, and to 2% for specific tuned frequency, by inserting the NEW FCF 250 Filter in the output line.

Sorensen

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

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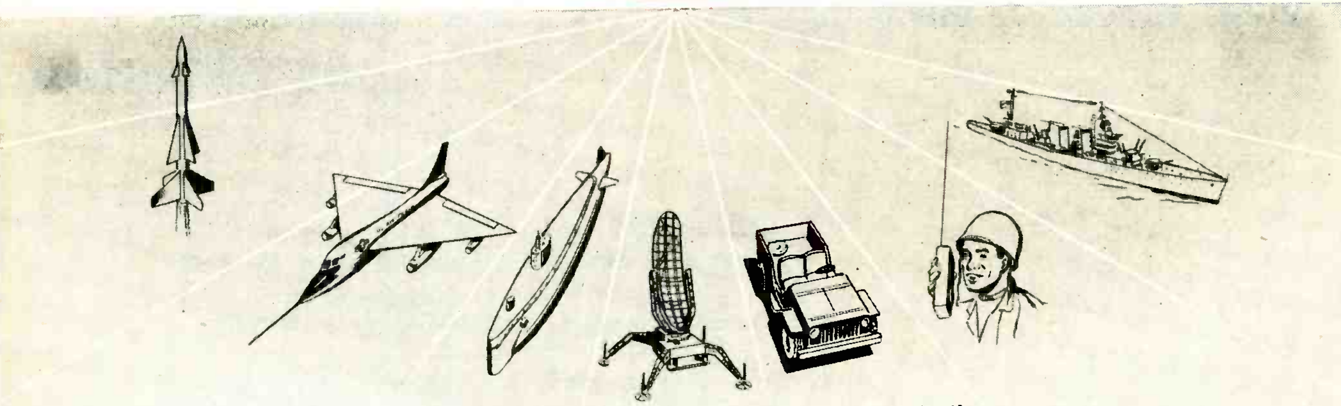
At your command for all military applications

THESE RAYTHEON RELIABLE PREFERRED TUBES



Approved Miniatures and Subminiatures for guided missile, computer, communication, radar, radiation measuring, instrument and other military applications requiring *Reliability Plus*.

	TYPE	DESCRIPTION	Spec. Number MIL-E-1/	Vibration Output (maximum) mVac	Heater Volts	Heater mA.	Plate Volts	Plate mA.	Grid Volts or Rk	Screen Volts	Screen mA.	μ	Sm μmhos
SUBMINIATURE	1AD4	RF Ampl. Pentode	20C	200*	1.25	100	45	3.0	Rg = 2 meg.	45	0.9	—	2000
	1AH4	RF Ampl. Pentode	316A	200*	1.25	40	45	0.75	Rg = 5 meg.	45	0.2	—	750
	5639	Video Amplifier Pentode	169C	100†	6.3	450	150	21	100Ω	100	4	—	9000
	5643	Thyratron	757C	—	6.3	150	epx = 500 v max; ip = 100 ma max; I_p = 16 mAdc max.						
	5672	RF Output Pentode	280	200*	1.25	50	67.5	3.25	−6.5	67.5	0.95	—	650
	5702WA	Video Amplifier Pentode	82B	50†	6.3	200	120	7.5	200Ω	120	2.6	—	5000
	5702WB	Video Amplifier Pentode	1069(N)	50† 240★	6.3	200	120	7.5	200Ω	120	2.6	—	5000
	5703WA	High Frequency Triode	293C	10†	6.3	200	120	9.4	220Ω	—	—	25.5	5100
	5703WB	High Frequency Triode	1070(N)	10† 50★	6.3	200	120	9.4	220Ω	—	—	25.5	5000
	5744WA	High Mu Triode	84C	25†	6.3	200	250	4.2	500Ω	—	—	70	4000
	5744WB	High Mu Triode	1073(N)	15† 75★	6.3	200	250	4.2	500Ω	—	—	70	4000
	5783WA	Voltage Reference	87C	20†	Operates at approximately 85 volts between 1.5 and 3.5 mA.								
	5784WA	RF Mixer Pentode	88D	100†	6.3	200	120	5.5	230Ω	120	4.1	—	3200
	5784WB	RF Mixer Pentode	1096(N)	75† 300★	6.3	200	120	5.5	230Ω	120	4.1	—	3200
	5787WA	Voltage Regulator	89B	20†	Operates at approximately 98 volts between 5 and 25 mA.								
	5829WA	Dual Diode	292A	—	6.3	150	Max. I_o = 5.5 mA. per plate						
	5902	Beam Pwr. Pentode	175C	100†	6.3	450	110	30	270Ω	110	2.2	—	4200
	6021	Medium Mu Dual Triode	188B	50†	6.3	300	100	6.5	150Ω	—	—	35	5400
	6088	Output Pentode	694	—	1.25	20	45	0.65	−1.25	45	0.15	—	625
	6111	Medium Mu Dual Triode	189B	50†	6.3	300	100	8.5	220Ω	—	—	20	5000
	6112	High Mu Dual Triode	190C	25†	6.3	300	100	0.8	1500Ω	—	—	•70	1800
	6533	Low Microphonic Triode	975	1.0†	6.3	200	120	0.9	1500Ω	—	—	54	1750
MINIATURE	OA2WA	Voltage Regulator	290B	100*	Operates at approximately 150 volts between 5 and 30 mA.								
	OB2WA	Voltage Regulator	291	—	Operates at approximately 108 volts between 5 and 30 mA.								
	6AH6WA	Video Pentode	1130	100*	6.3	450	300	10	160Ω	150	2.5	—	9000
	6AN5	Power Pentode	117	1000*	6.3	450	120	33	125Ω	120	11	—	8500
	6AN5WA	Power Pentode	839A	100*	6.3	450	120	33	125Ω	120	11	—	8500
	5517	Cold K Rectifier	690A	—	Peak Inverse = 2800 volts I_o = 12 mAdc.								
	5651WA	Voltage Reference	825A	—	Operates at approximately 85 volts between 1.5 and 3.5 mA.								
	5654/6AK5W	RF Amol. Pentode	4A	150*	6.3	175	120	7.5	−2	120	2.5	—	5000
	5670	Medium Mu Dual Triode	5A	100*‡	6.3	350	150	8.2	240Ω	—	—	35	5500
	5687WA	Low Mu Dual Triode	779A	100*	6.3	900	120	36	−2	—	—	18.5	11000
	5814A	Low Mu Dual Triode	12A	100*‡	6.3	350	250	10.5	−8.5	—	—	17	2200

*2.5g, 25 cps. fixed frequency
†15g, 40 cps. fixed frequency
‡Sections in parallel
(N) Navy Specification
All ratings for dual tubes are for each section
★Peak to peak, 15g, 30 to 1000 cps.

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ELECTRONICS NEWSLETTER

AMERICAN IRBM's will be delivered to at least four bases along Britain's east coast, it was reported at press time as the U.S. and Britain moved to complete negotiations for jointly controlled nuclear missile bases. Agreement is expected to set the pattern for distribution of missiles up to 1,500-mi range among other NATO allies.

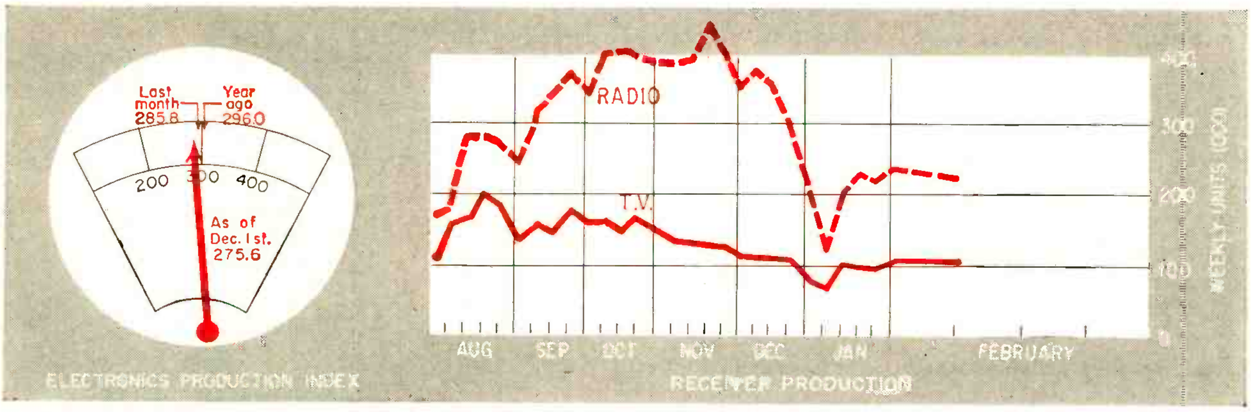
Meanwhile, West German sources said a ministerial level NATO meeting scheduled for March will take place instead in May. This should settle locations, types and numbers of missiles for all of NATO (ELECTRONICS, Jan. 10, p 34). It was reported that West Germany's defense ministry was going ahead with its own plan to set up three tactical missile units. Two would get Nike antiaircraft missiles and the third the Matador pilotless bombers, weapons already possessed by U.S. forces in West Germany.

TIME DELAY IN CONVERTING missile telemetry data from field tape recordings into useful printed information has been reduced from weeks to hours. A new Epsco data reduction system built for GE automatically prepares asynchronous telemetry data for analysis by large digital computers. GE's missile and ordnance people estimate initial cost of $700,000, including spare parts, will be repaid when data from twelve "shoots" has been processed.

EXPERIMENTAL GUIDANCE SYSTEM for automobiles described this month by General Motors (see photo p 18) is another good sign for our industry, but don't expect such electronics for autos for some time. Automatic driving along the nation's highways is far in the future, says GM's research v-p, Lawrence R. Hafstead. He visualizes first highway use in an "automatic lane" for cars equipped with the device that might be rented at a turnpike entrance. Unit price of mass produced device might be comparable to a conventional car radio.

Present GM system controls steering only. Most automakers are known to be working on automatic brake control. Right now, "radar-type" devices are working too well. They have difficulty in distinguishing metal highway signs, parked cars or farm equipment from real obstructions, and they must be turned off to permit passing.

NATIONAL SCIENCE FOUNDATION has just announced results of its survey of all research and development manpower in the U.S. in 1954, which should be of interest to electronics executives. Only 25 percent of all engineers and 40 percent of all scientists surveyed—or 23,000—were in R&D in the natural sciences. This includes 68,000 physical scientists, 139,000 engineers and 22,000 life scientists.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Feb. 7, '58	Jan. 31, '58	Feb. 8, '57
Television sets, total	103,730	119,748	116,134
Radio sets, total	224,149	245,861	319,386
Auto sets	76,794	79,890	135,055

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Feb. 12, '58	Feb. 5, '58	Feb. 13, '57
Radio-tv & electronics	45.55	46.90	62.10
Radio broadcasters	56.95	59.66	63.10

FIGURES OF THE YEAR

Totals for year

	1957	1956	Percent Change
Receiving tube sales	456,424,000	464,186,000	− 1.7
Transistor production	28,738,000	12,840,000	+123.8
Cathode-ray tube sales	9,721,008	10,987,021	− 11.5
Television set production	6,399,345	7,387,029	− 13.4
Radio set production	15,427,738	13,981,800	+ 10.3
TV set sales	6,560,220	6,804,756	− 3.6
Radio set sales (excl. auto)	9,721,285	8,332,077	+ 16.7

Conventional gyro with rotatable outer race bearing (left) and accurate integrating accelerometers are just two of the components that are now . . .

Improving I-G Systems

RECENTLY ANNOUNCED components for inertial-guidance systems promise to increase accuracy and reliability while decreasing cost and easing production bottlenecks. Two such components are the gyroscope and accurate integrating accelerometer shown above.

I-g systems are essential in ballistic missiles like the newly unveiled Sergeant (see below at right) and air-breathing missiles like the Matador Mace, which just completed a 650-mile unmanned cross-country flight. The systems are also important in nuclear submarines, enabling them to travel submerged to a predetermined spot before releasing missiles like the new Polaris.

Inexpensive and reliable i-g systems also would open a new field in robot-guided commercial aircraft—perhaps offering a solution for critical air-safety problems of the jet age.

A new coaxial gimbal bearing for conventional gyros (above, left), is said to reduce random drift errors by a factor of twelve. The device is called Rotorace by its developer, Sperry Gyroscope division of Sperry Rand.

With accuracy improved from 3 to 0.25 deg per hour, missiles using the new unit will be able to hit targets 150 miles away with a probable error of only 23 yards. Performance is on a par with floated gyros.

According to the manufacturer, the unit will be used in the compass system of the new Douglas DC-8 and Boeing 707 jet airliners. Pan American and KLM have installed it in their C-11 compass systems.

The new integrating accelerometer, (above, right), also by Sperry, is destined for use on aircraft, air-breathing missiles and atomic subs.

The unit weighs 1½ lb and is accurate within hundredths of one percent. Threshold sensitivity is 0.00001 g. That is, it can detect the gravity g force produced by tilting the accelerometer axis only 2 seconds of arc.

Three small metal cylinders form the accelerometer. The smallest is the sensor. It floats in silicone fluid. The next larger cylinder is supported on bearings within the case.

A small 1,000-rpm motor spins the middle cylinder and the fluid as well. Thus the sensor is supported only by the spinning fluid. Bypass tubes cushion fore-and-aft movement so that it causes internal velocity exactly proportional to externally applied acceleration.

Thermostatic controls in the outer shell hold temperature to plus or minus 1 deg despite 80-deg ambient swings.

New Infrared Is All Electronic

JOHNSONVILLE, PA.—PROGRESS report on development of an all-electronic infrared system at the Naval Air Development Center here promises infrared hardware that will be cheaper, simpler and more versatile than equipment now being used.

Known as Project Moocher, the system was conceived, and the work is being headed up, by Lt. Cdr. H. R. Walker.

Finished project, Walker says, will be useful to all services. Applications include guiding missiles, searching and tracking aircraft and missiles, and guiding troops through the dark. Cost per unit will be around $300. Absence of moving parts, light weight and mobility are still other advantages to the gear.

Needed at the moment is a new sensitive surface. Westinghouse Research Lab is currently making evaluations of certain sensitive surfaces as a possible solution.

But even if a conventional surface has to be used, Walker says, the project will still be a success. The real gimmick is *how* the surface is used. And that problem, though secret, is already solved.

Also working on a portion of Project Moocher is Evans Signal Lab at Fort Monmouth, N. J.

Up And Away

Blasting off at White Sands, New Mexico, is the Army's inertially guided Sergeant missile. This 30-ft JPL-Sperry missile succeeds the four-year-old radio-command-guided Corporal

Can You Call a Man a "Failure" at Thirty?

Men who think that success is only a matter of "a few years" are failures . . . however young they are!

How often have you heard some young man in business say, "I'll admit the job I have now isn't much but, after all, I'm only in my twenties."

Or: "Just about every executive in the company I work for is between 45 and 65. I have plenty of time to get ahead."

This *mistaken* idea that success comes automatically with time is easy to understand. Promotions do come regularly and effortlessly to young men of promise. *But* the day arrives, often abruptly, when that promise must be *fulfilled*. Native ability and intelligence can carry a man only to the mid-way point in business—beyond that he must *prove* his capacity to justify a position of executive responsibility. That calls for a practical, working knowledge of business fundamentals.

The time to build that knowledge—to lay a solid groundwork for your future progress—is now . . . *now* while time is still on your side. If you fail to recognize that fact, you'll know only struggling, skimping and regret when your earning power should be at its height.

FOR THE BUSINESS MAN WHO REFUSES TO STAGNATE

HALF the world is half asleep! Men who could be making twice their present salaries are coasting along, hoping for promotions but doing nothing to bring themselves forcefully to the attention of management. They're wasting the most fruitful years of their business lives... throwing away thousands of dollars they'll never be able to make up.

If *you* want to discover how to start to succeed while you're still young—if you want to avoid the heartbreak of failure in later years—send today for "Forging Ahead in Business"... one of the most practical and helpful booklets ever written on the problems of personal advancement. You will discover what the qualifications of an executive are in today's competitive market . . . what you must know to make $15,000, $20,000 or more a year . . . what you must *do* to accumulate this knowledge.

"Forging Ahead in Business" was written for ambitious men who seriously want to get down to bed-rock in their thinking about their business future; there's no charge for the booklet because, frankly, we've never been able to set a price on it that would reflect its true value. Some men have found a fortune in its pages. If you feel that it's meant for you, simply fill out and return this coupon. Your complimentary copy will be mailed to you promptly.

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FAST, HAMMER-DRIVEN RIVET ECONOMICAL FOR BLIND AND OPEN APPLICATIONS

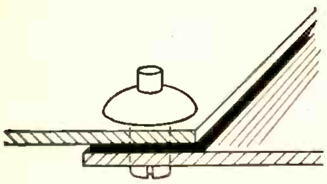


Fig. 1 Inserted in hole, Southco Rivets are quickly set by driving pin with hammer. No special tools are required. Bucking is not necessary.

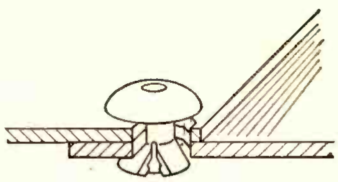


Fig. 2 Expanded prongs force sheets or parts together, hold them tightly in compression. No metal is removed, no grinding or finishing is required.

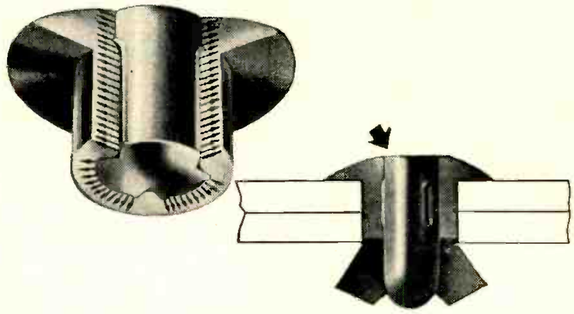


Fig. 3 Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

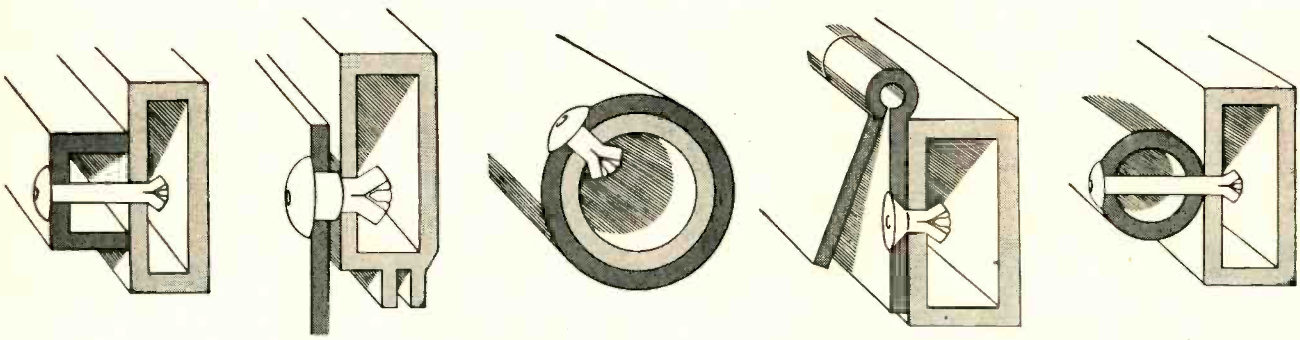


Fig. 4 Ideally suited for "blind" applications, Southco Rivets are worked by one man from one side only and require minimum space inside closed area. They eliminate costly bucking arrangement or time-consuming finishing. Supplied as a unit, they require no job time for assembly or fitting.

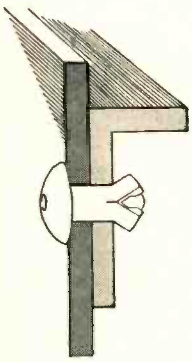


Fig. 5 Access or open fastening utilizes the simplicity, speed and vibration-resistance of Southco Rivets.

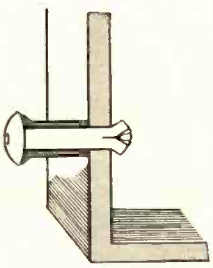


Fig. 6 Ferrules are used as spacers for numerous applications. Here the Southco Rivet forms a drawer pull in conjunction with a flanged tube.

*TRADE MARK OF SOUTH CHESTER CORP.

Fig. 7 Increased head size distributes holding pressure over larger area, permits higher loading on wood, plastics and similar materials.

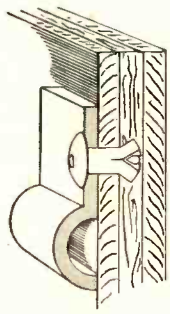
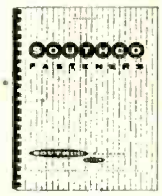


Fig. 8 A blind head can be formed inside the wood. This application is particularly useful when it is desirable to have one surface of the wood unmarred.

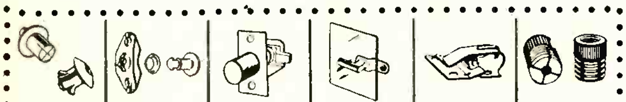
FREE!

Fastener Handbook



Send for your free copy of Handbook No. 7. Complete data for designers on these and many other specialty fasteners. 52 pp., two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pennsylvania.



BLIND RIVETS	¼ TURN FASTENERS	ADJ. PAWL FASTENERS	DOOR LATCHES	RETAINING SPRINGS	ANCHOR NUTS

SOUTHCO FASTENERS LION

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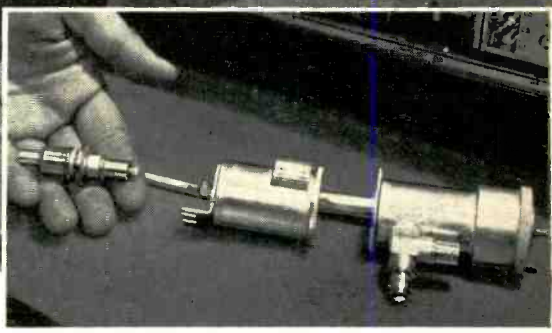
(Left to Right) Frank Marshall, Assistant Engineer, Arthur E. Wulfsberg, an Assistant Director of Research & Development, and John Sprengeler, Project Engineer, discuss the use of a General Electric GL-6442 in a power amplifier assembly which is part of the AN/ARN-46 receiver-transmitter unit shown in center foreground.



Disassembled power amplifier from AN/ARN-46. A G-E GL-6442 is used in each of 3 such amplifiers within the TACAN receiver-transmitter unit.

Collins Airborne TACAN Uses General Electric GL-6442 For Reliable Performance

EXCEPTIONAL performance characteristics of General Electric tube type GL-6442 are contributing significantly to the accurate and reliable performance of Collins TACAN equipment, which is capable of operation at altitudes over 70,000 feet.

TACAN provides the military or civil pilot with continuous, precise distance and bearing information for navigation at ranges up to about 200 miles.

The pressurized receiver-transmitter unit of the equipment employs five G-E GL-6442's—ceramic, disc-seal triodes of planar construction—in the frequency multiplier and power amplifier systems. Three of the tubes are used in the pulse-modulated final amplifier. These tubes are mounted in coaxial resonators, tunable over a 1025-1150 mc. range. More than 1 KW peak power output is obtained.

Designed primarily for use in grounded-grid cavity circuits as a plate pulsed oscillator or amplifier up to 4000 mcs., the tube is also useful as a continuous-wave RF power amplifier, oscillator, or frequency multiplier up to 2500 mcs. Typical operation in plate-pulsed oscillator service at 3500 mcs. produces 2 KW peak power output with an average power input of 7.5 watts and a duty cycle of 0.001.

Ratings for other classes of service available on request. For full information on Type GL-6442, call your regional G-E power tube representative. *Power Tube Dept., General Electric Co., Schenectady 5, N. Y.*

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CIRCLE 7 READERS SERVICE CARD

Columbia Tells Upgrading Plan

Upgrading of top-potential electronics engineers in industry through a special university program was proposed this month by Columbia University. Columbia's new part-time day plan for New York area firms strengthens the trend, most apparent on the West Coast, towards more advanced training for engineers.

Wide industry support is sought, but emphasis on quality over quantity is such that only one of three students are likely to enter the program from each participating firm.

Program will start in September in the electrical engineering department of Columbia's School of Engineering. It extends the school's regular graduate program for engineers in industry to include daytime courses. Students will be nominated by their companies, based on the employer's estimate of their potential.

During two 32-week academic years the new program will take top calibre students away from their engineering jobs two days a week. Studies will lead to master of science degree or doctorate.

Courses will cover such areas as electronic circuitry, physical electronics, computers, control systems, electromagnetic theory, microwave engineering and energy conversion. Daytime studies mean that students will get the benefit of more personal contact with top professors and more seminars.

Program would cost companies $1,184 for 32 points at $37 a point. Donation of an equal sum by the companies in recognition of the higher actual cost of educating an engineer is optional.

Dean John R. Dunning told electronics executives at a recent luncheon that the new Columbia plan is part of a national movement in engineering education towards more special graduate training. This is largely a matter of upgrading scientific and engineering talent, he said, in which "industry as well as education has a real stake."

Dunning urged that "people be

WASHINGTON OUTLOOK

Pentagon officials are pushing out more missile news than ever before. The Army's success with its Explorer satellite has tended to make release of information more on a normal (for the Pentagon) basis than in recent months.

Biggest administrative development is in surface-to-surface missiles of more than 200 mi range. Now, the Army's ceiling is based on weight and mobility of missile rather than range alone. If the missile can be carried and launched from a vehicle like a truck, the Army can have it.

The Pershing missile now under development at Redstone Arsenal will be the first solid-propellant vehicle in the 200-mi-plus-range class; it will succeed the Redstone.

Here's a rundown on missile news, names and contractors.

Corporal—Cary Multiplier, San Gabriel, Calif., produces the gyro and controls for this tactical missile.

Nike-Zeus—Grand Central Rocket, Redlands, Calif., is developing the solid-propellant rocket for this Air Force anti-ICBM system.

Sergeant—Cal Tech's Jet Propulsion Laboratory, Pasadena, Calif., and Sperry Gyroscope, Salt Lake City, are primes; solid-fuel motor will be supplied by Thiokol Chemical.

Corvus—New Navy air-to-surface missile has Temco Aircraft, Dallas, as prime; principal subs are Reaction Motors for propulsion and Texas Instruments and W. L. Maxson on guidance.

Sidewinder—Contractors on this operational air-to-air missile include Philco; General Electric; Norris Thermodor, Los Angeles; Hunter Douglas, Riverside, Calif.; Eastman Kodak; Minneapolis-Honeywell; Elgin Watch; Baldwin Piano; Houdaille Industries; Bulova; Hamilton Watch; Beatrice Field Tank Co., Allied Federal Industries; Electronics Corp. of America; IR Industries, Bausch and Lomb; American Machine and Foundry.

Bull Goose—Fairchild Engine and Airplane is the prime contractor for this Air Force electronic countermeasures missile—a decoy to be used in an attack on an enemy. Also involved: Ramo-Wooldridge, American Machine and Foundry; and Paul Omohundro Co.

Green Quail—McDonald Aircraft is prime contractor for this air-launched diversionary missile. Also involved: Ramo-Wooldridge, American Machine and Foundry and General Electric.

Mace—Martin is prime contractor on this successor to the Martin-built pilotless-plane, Matador. Guidance is from GM's AC Sparkplug division.

Hound Dog—North American Aviation has development of this top secret air-to-surface missile to be launched from a B-52 bomber.

- **The Air Force** claims its new $1-billion ballistic missile detection system will provide precise and sharp beams designed to give better than 99 percent probability of raid detection with a relatively low rate of false alarms.

  The complex antenna system allows for discrimination between missiles, meteors and satellites. First contracts, valued at about $329 million, are going to RCA, Western Electric, GE, Sylvania and several other electronics companies. RCA has the prime contract.

NOW! END READOUT CONFUSION...

with the new KIN TEL digital voltmeter

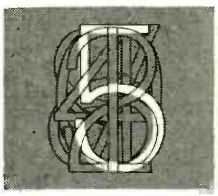
ANOTHER FIRST FROM KIN TEL! Here is a digital voltmeter that shows numbers on a readable single plane! With KIN TEL's new design, there are no superimposed outlines of numbers in the picture...no confusion caused by dials and old style numerical readouts. This digital readout uses a simple projection system – provides 7,000 to 8,000 hours of lamp life, compared with 100 to 200 hours for ordinary readouts.

FIRST OF A COMPLETE LINE OF DIGITAL INSTRUMENTS! Others include: Converters for measuring AC, ohms, ratios...multiple input scanners . . . serial converters to drive typewriters and punched tape units.

WIDE APPLICATION! KIN TEL digital instruments are ideal for automatic check-out systems for missiles and rockets; computer measurements; process control monitoring; production testing; test system calibration; strain gage, thermocouple and other transducer measurements, and calibration of laboratory and industrial electronic instruments.

Talk to your local KIN TEL representative. Sales and service everywhere. Or write us direct for further information.

See the difference!



ORDINARY READOUT

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CLEAR AND SHARP, ANY WAY YOU LOOK AT IT

- *100 Microvolt Sensitivity*
- *Automatic, Continuous Standard Cell Calibration*
- *High Reliability*
- *0.0001 to 999.9V—Plus Automatic Decimal and Polarity Indication*

SPECIFICATIONS

Display...Four (4) digit with automatic polarity indication and decimal placement. Total display area 2″ high x 7.5″ long, internally illuminated. Individual digits 1.25″ high.

Automatic Ranges...0.0001 to 999.9 volts covered in four ranges.

Accuracy...0.01% or 1 digit, whichever is larger.

Counting Rate...30 counts per second, providing average balance (reading) time of 1 second, maximum balance time of less than 2 seconds.

Reference Voltage...Chopper-stabilized supply, referenced to an unsaturated mercury-cadmium standard cell.

Input Impedance...10 megohms, all ranges.

Output...Visual display, plus print control. Automatic print impulse when meter assumes balance. No accessories required to drive parallel input printers.

Input...115 volt, 60 cycle, single phase, approximately 75VA.

Dimensions...Control unit, 5¼″ high x 19″ wide x 16″ deep. Readout display, 3½″ high x 19″ wide x 9″ deep

Weight...Approximately 40 lb.

Price...$2,100

Over 10,000 KIN TEL instruments in use today!

KIN TEL

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San Diego 11, California

A Division of Cohu Electronics Inc.

upgraded to the maximum . . . so that best use can be made of their capabilities." The cost is high to a university, he added. Almost 60 percent of the cost of educating a graduate engineering student at Columbia is not covered by tuition and must be borne by the university.

New Stereo Disk Uses F-M Carrier

ANOTHER ENTRY in stereo phonograph record sweepstakes is a proposed system which has directional information superimposed on supersonic f-m carrier, plus conventional lateral microgroove. Records may be reproduced either monaurally or in stereo with conventional monaural pickup, maker says.

News confirms an earlier report (ELECTRONICS, Jan. 10, p 31). Developer is Components Corp. of Denville, N. J. Advantages claimed include elimination of one preamplifier, less critical pickup adjustments for azimuth and tracking, reduced differential noise.

The two stereo channels from a conventional master tape are combined both in phase and out of phase in the rerecording process. The sum signal comprises the main groove modulation, while the difference signal modulates a 24-kc f-m carrier and is multiplexed into the disk cutter.

Upper limit of 5 kc for the difference signal is presently restricted by a low-pass filter, but it is expected this can be raised to 8 or 10 kc. Overall system response required is 30 kc, which can be achieved with 0.5-mil tip radius on reproducing stylus.

For stereo reproduction, any conventional wide-range pickup is fed into a special preamplifier, which in addition to the RIAA equalization characteristic, also has a limiter and discriminator for the f-m difference channel. The sum signal is then split and fed to both speakers, simultaneously and in phase, while the difference portion is fed in phase with the signal in one speaker, and out of phase with that in the other. Crosstalk is said to be down 30 db.

MILITARY ELECTRONICS

• Sperry is about ready to announce a multi-million-dollar weapons systems manager contract with USAF for development of long range radar.

• Look for Sylvania to announce within the next few weeks three additional contracts in the field of missile defense including electronic countermeasures.

• Branching radio frequency amplifiers will be used in Project Globecom, a communication system linking the U.S.'s farflung air bases throughout the world. Produced by Hallamore Electronics div. of Siegler, the amplifier allows connection of six communications receivers to a single antenna without objectionable inter-action or inferior performance in individual circuits.

The amplifier is made up of four main subassemblies consisting of a preamplifier, output distribution amplifier, power supply and control panel. Hallamore's contract for 1394 sets comes to $787,250.

• ARDC says the electronics industry would profit by taking more advantage of its Technical Program Planning Documents system through which USAF's future needs are stated and sent out to interested firms.

Specific areas TPPD's cover include: communications, electronic counter and counter countermeasure, air terminal control, electronic techniques, intelligence data handling, reconnaissance data collection, and search, identification and tactical control.

Requests for TPPD's are made to Commander, ARDC, Andrews AFB, Washington 25, D. C., to the attention of RD %DSP.

Semiconductor amplifier operates up to 500 mc

French Reveal New Amplifier

FRANCE'S National Center of Telecommunications Studies has announced a semiconductor amplifier that operates at frequencies up to 500 mc.

The device, called the Tecnetron, is a cylindrical rod of germanium 2 mm long and 0.5 mm in diameter, containing a slot filled with indium. National Center hopes by the end of the year to perfect a model that will reach a frequency of more than 1,000 mc and a power of several watts.

French government owns rights to the device.

Fusion Boosts Electronics Role

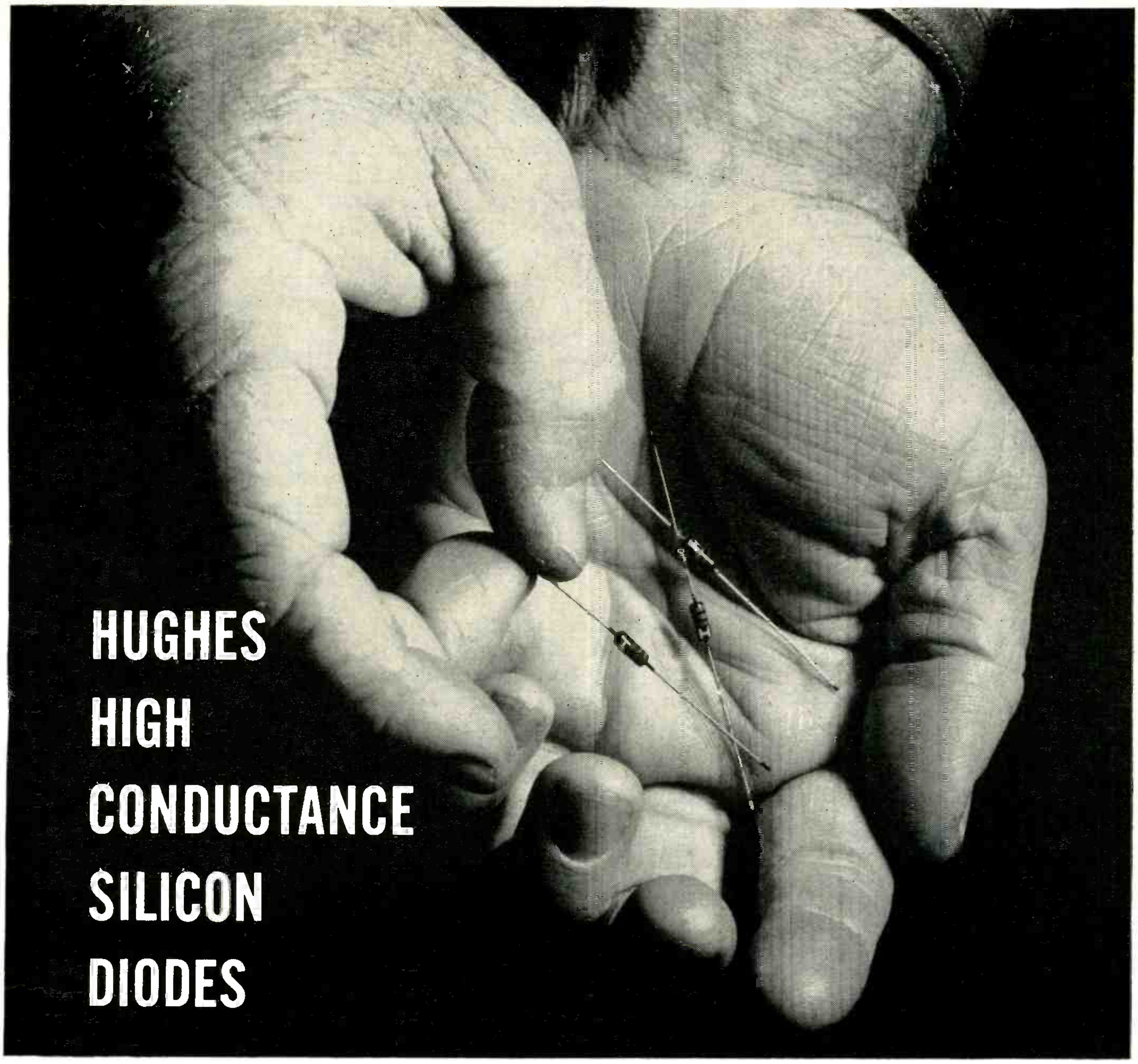
AS THE POSSIBILITY of a practical fusion reactor moves into the realm of probability, electronics will play a more vital role—in fact a key role—in nuclear engineering.

That was the comment made this week to an ELECTRONICS editor by Manson Benedict, head of the newly created Department of Nuclear Engineering at MIT.

Benedict, a physical chemist who got into nucleonics as a scientist for the Manhattan Project, pointed out that electronics now has an important, but auxiliary role in fission reaction. Electronic instrumentation and circuitry are used in the the process "from initial signal to actuation of controls."

But training in electronics will be even more important for thermonuclear reaction, Benedict added, since high temperature plasma physics is "the heart of the subject."

The $2,640,000 nuclear reactor at MIT, which will be completed this Spring, will serve as a laboratory for the new department, one



Hughes, many years a leader in the semiconductor industry, has added another series to its expanding line. These new units can withstand temperatures as high as 200°C while sustaining all the important features your circuits demand:

- high forward conductance
- high reverse voltage
- low dynamic forward resistance
- high back resistance at high temperatures and/or high voltages

They are quality diodes, rugged and reliable like all Hughes diodes. And each is packaged in Hughes' famous glass envelope, designed for complete protection from contamination and moisture penetration. Maximum body dimensions: .107" x .265".

Special types are available, too. Perhaps you have a design with unique requirements and can't find the right diode for the job. If so, ask for a call from one of our sales engineers or visit our booth at the IRE show this month. Either way, we would be pleased to discuss your requirements.

Type Number*	Max. Forward Current @ +1 Volt	Max. Rated Average Forward Current @ 25°C	@ 150°C	Max. Inverse Current @ 25°C	@ 150°C	Test Voltage	Max. Rated Inverse Operating Voltage
1N482B	100mA	200mA	50mA	.025μA	5μA	30V	36V
1N483B	100mA	200mA	50mA	.025μA	5μA	60V	70V
1N484B	100mA	200mA	50mA	.025μA	5μA	125V	130V
1N485B	100mA	200mA	50mA	.025μA	5μA	175V	180V
1N486A	100mA	200mA	50mA	.050μA	25μA	225V	225V
1N487A	100mA	200mA	50mA	.100μA	25μA	300V	300V

(*Lettered and unlettered versions not listed are available.)

Hughes has related types with higher forward currents. Here are three of the many which could be listed:

HD6764	200mA	200mA	50mA	.025μA	5μA	60V	70V
HD6768	200mA	200mA	50mA	.025μA	5μA	175V	180V
HD6773	200mA	200mA	50mA	.025μA	5μA	300V	300V

For printed literature, please write: Semiconductor Division, HUGHES PRODUCTS, International Airport Station, Los Angeles 45, California

Creating a new world with ELECTRONICS

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of the first of its kind in the U.S.

First course in nuclear engineering at MIT was offered in 1952. The new department will be a division of the School of Engineering, of which C. Richard Soderberg is dean. Teaching will dovetail with a research program, which will include studies of atomic energy for medical and industrial as well as scientific purposes. By 1960 industry expects to need 16,000 nuclear engineers, Soderberg said. A 1957 study showed about 9,000 were employed by industry in the atomic energy field.

In addition to classes in Cambridge, Mass., nuclear engineering students may attend the Engineering Practice School conducted by MIT at Oak Ridge, Tenn.

Study in the new department will require a background in physics, mathematics and engineering. Classes will be open to undergraduates, but the department will give degrees only for graduate work. Establishment of the new department will be effective July 1.

This year 94 students have been registered for graduate study in the peaceful application of atomic energy. Of these, 23 are from MIT and the others come from a total of 49 institutions, including Annapolis and West Point. They include 17 foreign students.

FINANCIAL ROUNDUP

• **Taylor Instruments,** Rochester, N. Y., drops plan to offer 99,195 shares of additional common stock to its stockholders. The offering, originally planned for last October, was postponed because of market conditions. Conditions are still not ripe for the issue, comments Raymond E. Olsen, president of the firm. Prospectus data furnished to the Securities and Exchange Commission last fall is now outdated and the company has withdrawn its SEC registration. Firm had planned to retire $2.5 million of bank loans with proceeds of stock issue. Instead, the loans have been continued.

• **Electro Precision Corp.,** Arkadelphia, Ark., offers 60,000 shares of common stock at $4 per share to bona fide residents of Arkansas. The new firm was organized to manufacture electronic controls and instruments used in automatic manufacturing. Proceeds will go for new equipment, inventory and working capital. Nunn-Groves Co. of Little Rock, Ark., is handling the underwriting.

•**Telecomputing Corp.** of Los Angeles reports an enviable income tax position for the next few years. It has an operating loss carry-forward from 1954 and 1955 of approximately $790,000 to apply against taxable income for the years 1958 and 1959. Approximately $483,000 of this amount is available to 1960. Firm's net income for the 10 months ended Oct. 31, 1957 was $728,850. It makes computing gear, gyroscope, components, test units, control devices.

• **Texas Instruments** was one of the star performers on the New York Stock Exchange last year. Price of TI stock increased 46.6 percent between close of 1956 and close of 1957, a gain exceeded only by seven NYSE listed firms. TI closed at 18¼ in 1956 and at 26¾ in 1957. Final 1957 quotations of three out of four firms were below their final 1956 quotations.

• **Fairchild Camera & Instrument Corp.,** Syosset, L. I., N. Y., forms new **Defense Products Division** through integration of its **Electronics Division** and **Reconnaissance Systems Division.** Move was made because future reconnaissance systems will require integration of our background in reconnaissance and electronics, says John Carter, Fairchild president.

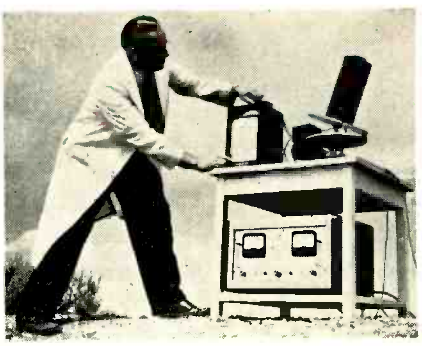
DIVIDENDS: **Raytheon** declares 5 percent stock dividend, payable March 5 . . . **Siegler Corp.,** regular quarterly dividend of 20¢, March 3 . . . **Television Electronics Fund,** 8¢ per share from investment income, Feb. 28.

Mobile Counters Track Radiation

SAFETY PERSONNEL at AEC installations track down escaping radiation like FC inspectors. Mobile atmosphere counters locate trouble spots by the employment of triangulation. Counter-equipped vehicles make fast ground surveys. Fixed, remote stations handle routine area monitoring.

Upwards of 200 mobile air monitors are estimated to be in use. Early models were custom built, but as the nuclear industry expanded, a commercial market developed.

Remote counting stations are also in commercial production. Multichannel installations are used to bring readings to central control points. They are hung on piping in homogeneous reactors to detect leaks and start safety circuits. Firms which handle large radiation sources employ them as door interlocks.

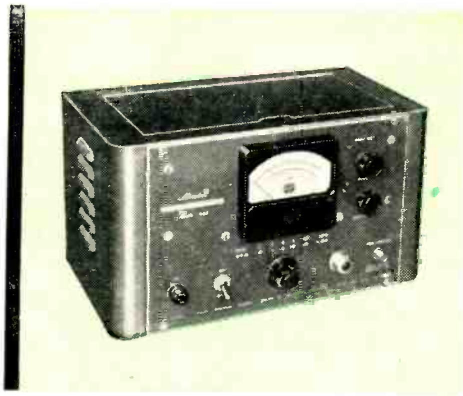


Mobile atmosphere radiation monitor finds radioactivity released from reactor stacks

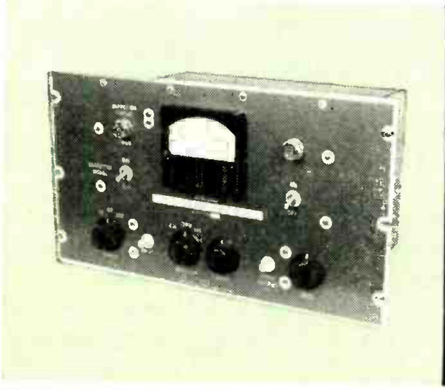
One firm estimates the potential market for these two classes of instruments is of the order of hundreds a year. The cost of its mobile air monitor is under $4,000, and the remotes sell for $500 a channel.

In addition, the firm has sold about 200 single channel remote counters for civilian defense use. The counters are installed on top of a firehouse or other CD station. The indicator and alarm stays inside.

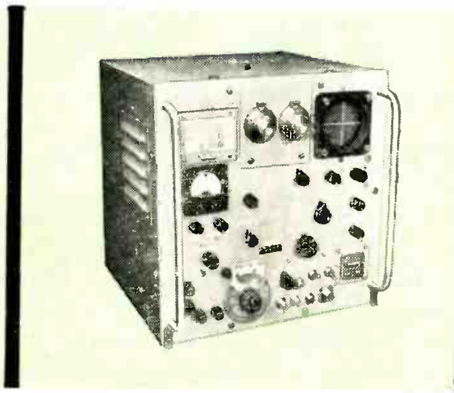
For precise power measurements in all bands



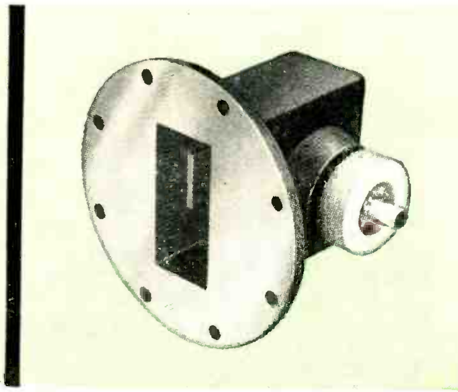
Microline® 123B Wattmeter Bridge. Measures average power to accuracy of 3%. Self-balancing and direct-reading, bridge operates with Microline barretter or thermistor mounts. Frequency coverage depends on mount used.



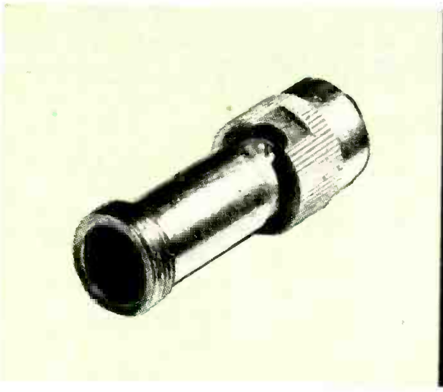
Microline 630 Peak Power Meter. New direct-reading meter measures true peak power in radars and other pulse systems. Readings, indicated continuously, are independent of width, shape, and repetition rate of pulse.



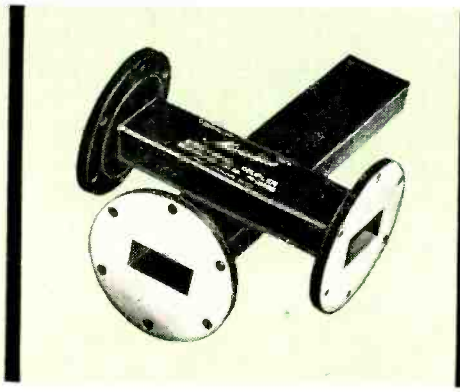
Microline Combination Test Sets. All are capable of measuring both peak and average power in radar systems. Also do the job of three or more standard test sets in measuring many other important system parameters. Special gating feature selects and identifies any pulse of a multi-pulse group for peak power measurement and spectrum observation. Available for Lp, S, C, X, K, and V band systems.



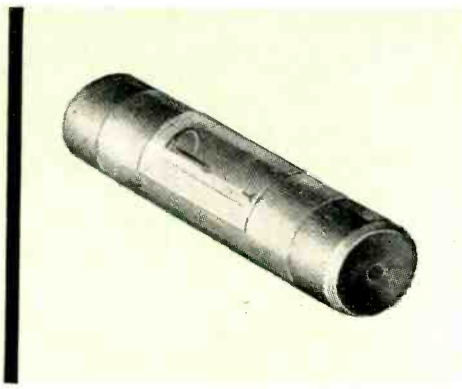
New Microline Barretter Mounts. For peak or average power measurements, these mounts are fixed-tuned and broad-banded to cover complete frequency range of their waveguide with high internal efficiency. Designed with low shunt capacity especially for peak power measurements with Microline 630 Meter. Barretters can be replaced by user. Three mounts cover all frequencies from 2.5 to 12.4 kmc.



Other Microline Barretter and Thermistor Mounts cover coaxial and waveguide lines for frequencies between 0.82 and 9.6 kmc. All Microline mounts are fixed-tuned for low VSWR over their bands.



Microline Directional Couplers. For sampling system power for measurement and test purposes. Available for coaxial and waveguide lines covering 0.96 to 40.0 kmc. Coupling ratios cover 10 to 50 db. Dual couplers are available for special comparative and ratio techniques, such as reflectometer measurements for fast production testing.



Microline Barretters and Thermistors. Precision elements for reliable power measurements as well as linear detection and probe uses. Seven types are available for special requirements of all types of power measurements, frequency bands, and bridge or meter circuits.

Now available from Sperry for immediate delivery is a complete line of Microline® equipment for measuring power in all bands. Ready to meet the growing demand for instruments capable of a high order of accuracy, Microline equipment design is based on Sperry's wide experience in developing precision test and production equipment for major weapon and defense systems. Write our Microwave Electronics Division for latest data on "Microline Power Measuring Instruments."

MICROWAVE ELECTRONICS DIVISION

SPERRY *GYROSCOPE COMPANY*
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN · CLEVELAND · NEW ORLEANS · LOS ANGELES SEATTLE · SAN FRANCISCO. IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

CIRCLE 10 READERS SERVICE CARD

Radio Controls Seaway Traffic

A FOUR-STATION radio network will be used to direct traffic through the St. Lawrence Seaway slated for completion early in 1959.

Aim of the system will be to prevent congestion at the seven locks by giving vessels using the 2,400 mi seaway instructions as to speed, etc.

System's four transmitters will be at Cote-St. Catherine, Beauharnais, Eisenhower and Iroquois.

"Vessels using the seaway will not need additional equipment," says Sydney Hairsine, head of Canadian Seaway Authority's electrical and mechanical division.

The transmitters will broadcast on existing frequencies determined by the longstanding Great Lakes Agreement between U.S. and Canada. Output power will be about 75 watts to cover distances not exceeding 25 miles.

Driving With No Hands

Electromagnetic auto guidance system enables driver to light a cigarette as vehicle enters turnaround loop on check road at GM Technical Center. Wire embedded in pavement carries 40 w at 2,000 cps a-c. Pair of tuned pick-up coils on front bumper straddle magnetic field about the wire, feeding voltage variations caused by lateral movement to a small analog computer installed in car's glove compartment. Computer drives a servo system to control steering. **(See Newsletter, p 7)**

MEETINGS AHEAD

FEBRUARY						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

MARCH						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24/31	25	26	27	28	29

APRIL						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

Mar. 3-5: Fourth Annual Electronics Conf., American Management Assoc., concurrent with AMA Annual Exhibit of Electronic Data Processing Equip., Statler Hotel, N.Y.C.

Mar. 8: American Society for Quality Control, Toronto Sect., Forum: Basic Training in Statistical Quality Control, contact Treasurer, Box 7, Toronto 15.

Mar. 17-21: 1958 Nuclear Congress, Engineers Joint Council, AICE, and Atomfair, Atomic Industrial Forum, International Amphitheatre, Chicago.

Mar. 24-27: IRE National Convention, All Prof. Groups, Waldorf-Astoria Hotel and N.Y. Coliseum, N.Y.C.

Mar. 31-Apr. 2: Instruments & Regulators Conf., PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Mar. 31-Apr. 2: Southwest District Meeting of AIEE, Mayo Hotel, Tulsa, Oklahoma.

Apr. 2-4: Conf. on Automatic Optimization, PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Apr. 8-10: Symposium on Electronic Waveguides, Microwave Research Institute of Brooklyn Polytechnic Inst., held at Engineering Societies Bldg. N.Y.C.

Apr. 10-12: Tenth Southwestern IRE Conference and Electronics Show, St. Anthony Hotel and Municipal Auditorium, San Antonio, Texas.

Apr. 14-16: Conf. on Automatic Techniques, IRE, ASME, Statler Hotel, Detroit, Mich.

Apr. 15: Closing date for registration, Intensive course in Automatic Control scheduled for June 16-25 at Univ. of Mich., Coll. of Engineering.

Apr. 17-18: Second Annual Tech. Meeting, Institute of Environmental Engineers, Hotel New Yorker, N.Y.C.

Apr. 18-19: Twelfth Annual Spring Tech. Conference on Television and Transistors, Engineering Society of Cincinnati Bldg., Cincinnati, Ohio.

Apr. 20-24: Scientific Apparatus Makers, 40th Annual Meeting, El Mirador Hotel, Palm Springs, California.

Apr. 22-24: 1958 Electronic Components Conf., IRE, AIEE, Ambassador Hotel, Los Angeles, Calif.

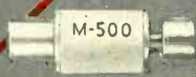
Tarzian . . .

FIRST

with Mass Produced
Low Priced . . . High Quality

FERRULE-TYPE

Silicon Power Rectifiers



(ACTUAL SIZE)

Now . . .

FIRST AGAIN

with Mass Produced
Low Priced . . . High Quality

LEAD-TYPE

Silicon Power Rectifiers

(ACTUAL SIZE)

● M-500 - 1N1084

Max. Peak Inv. Volts		400
Max. DC MA	100°C	500
	150°C	250
Max. RMS Volts		280
Max. RMS MA	100°C	1250
	150°C	625
Max. Rec. Peak MA	100°C	5000
	150°C	2500
Max. Surge Amperes	100°C	30
	150°C	15

● 40K - 1N1442

Max. Peak Inv. Volts		400
Max. DC MA	55°C	750
	100°C	500
	150°C	250
Max. RMS Volts		280
Max. RMS MA	55°C	1875
	100°C	1250
	150°C	625
Max. Rec. Peak MA	55°C	7500
	100°C	5000
	150°C	2500
Max. Surge Amperes	55°C	30
	100°C	30
	150°C	15

As you prefer—we can supply you with either ferrule or lead mounting.
Also available—voltage ratings of 100, 200 and 300 volts peak inverse on both types.
Write for complete information.

Sarkes Tarzian, INC.

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Dept. D-1

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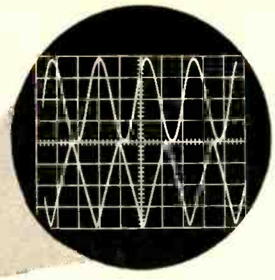
CIRCLE 11 READERS SERVICE CARD

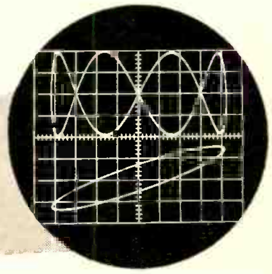
NEW DUAL-BEAM OSCILLOSCOPE

Tektronix Type 502

- TWO-GUN CATHODE-RAY TUBE.
- 200 μv/cm SENSITIVITY, BOTH BEAMS.
- DIFFERENTIAL INPUT, ALL SENSITIVITIES.
- 2, 5, 10, and 20 TIMES SWEEP MAGNIFICATION.
- CURVE TRACING with TWO BEAMS—(horizontal input sensitivity to 0.1 v/cm).
- SINGLE-BEAM CURVE TRACING at 200 μv/cm, BOTH AXES.
- EXTRA FEATURE—Both amplifiers have transistor-regulated parallel heater supply.



Dual display on linear time base.



Dual display for X-Y curves.

Here are a few uses for the Type 502:

IN ELECTRONICS—Use the Type 502 as a general-purpose oscilloscope and also to show simultaneously the waveforms at any two points in a circuit, e.g. input and output, opposite sides of a push-pull circuit, trigger and triggered waveform, etc.

IN MECHANICS—Display, compare, and measure outputs of two transducers on the same time base; plot one transducer output against another—pressure against volume or temperature for instance; measure phase angles, frequency differences, etc.

IN MEDICINE—Display, compare, and measure stimulus and reaction, or the outputs of two probes, on the same time base; use differential input to cancel out common-mode signals, or to eliminate the need for a common terminal; use in routine investigations, etc.

IN ALL FIELDS—The Type 502 can save you more than its cost in time—in as little as one application!

TYPE 502 CHARACTERISTICS

HIGH-GAIN AMPLIFIERS

200-microvolts/cm deflection factors, both dc-coupled and ac-coupled. 16 calibrated steps from 200 μv/cm to 20 v/cm.

Passbands— dc-to-100 kc at 200 μv/cm, increasing to dc-to-350 kc at 1 mv/cm and dc-to-500 kc at 50 mv/cm to 20 v/cm.

Differential Input, Both Channels—Rejection ratios: 1000-to-1 at 1 mv/cm or less, 100-to-1 at 0.2 v/cm, 50-to-1 at 5 to 20 v/cm.

Constant Input Impedance (1 megohm, 47 $\mu\mu$f) Both Channels—from 1 mv/cm to 20 v/cm, for use with Tektronix P510A Probes. (2-P510A Probes furnished).

WIDE-RANGE SWEEP CIRCUIT (Common to both beams)

Single-knob control for selecting any of 22 accurately-calibrated sweep rates from 1 μsec/cm to 5 sec/cm.

Sweep Magnification—2, 5, 10, and 20 times, accurate within the maximum calibrated sweep rate.

Automatic Triggering—fully automatic, or preset with amplitude-level selection when desired. Sweep can also be operated free-running.

X-Y CURVE TRACING OPERATION

Horizontal-input amplifier permits curve-tracing with both beams simultaneously at sensitivities to 0.1 v/cm. For curve tracing at higher sensitivities (to 200 μv/cm) with one beam, one of the vertical amplifiers can be switched to the horizontal-deflection plates.

OTHER FEATURES

Amplitude calibrator, 1 mv to 100 v in decade steps—square wave, frequency about 1 kc.

3-kv accelerating potential on new Tektronix 5" dual-beam crt. 8-cm by 10-cm linear-display area, each beam.

Electronically-regulated power supplies. Price . . . . **$795** f.o.b. factory

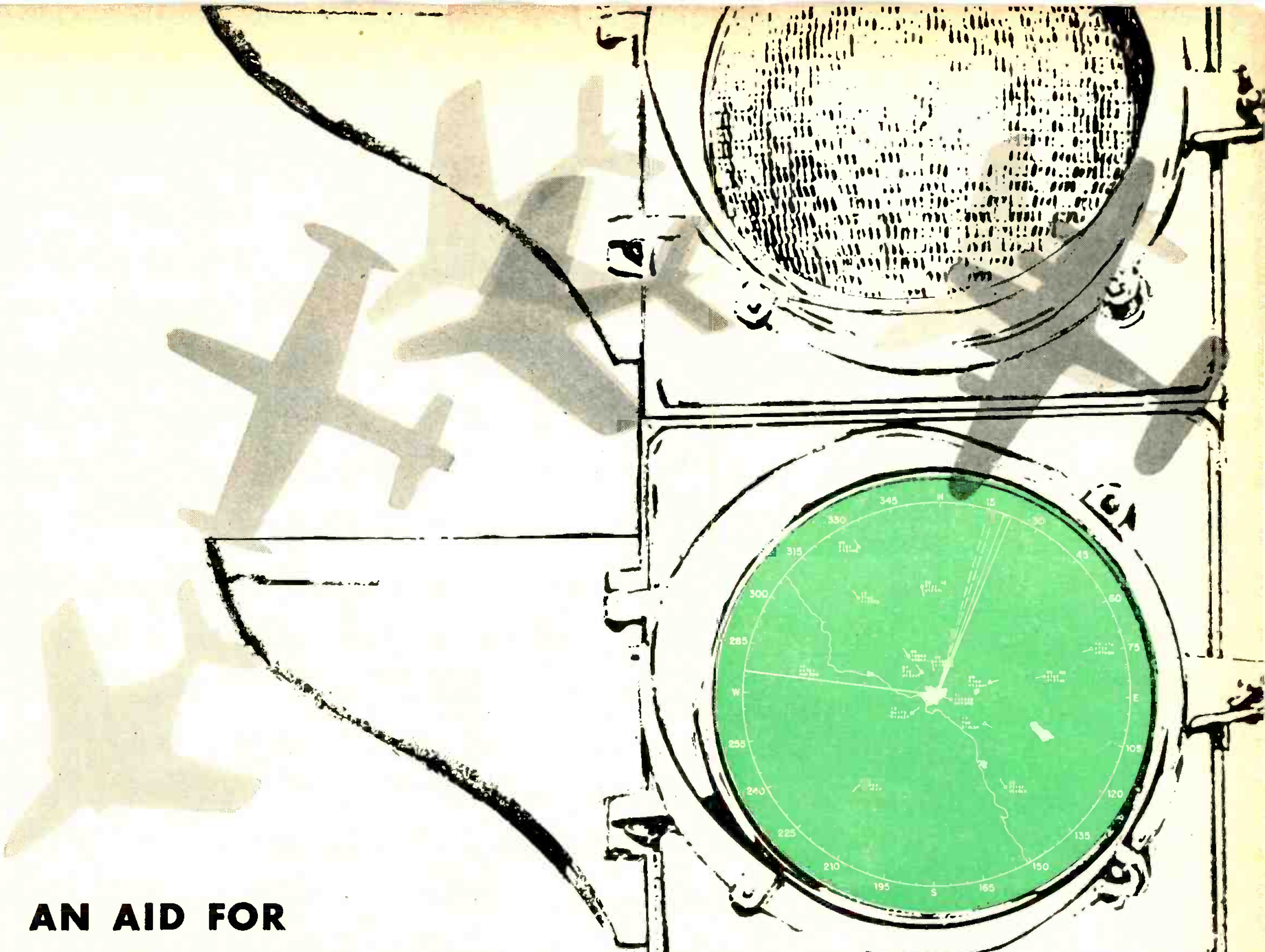
IF YOU ATTEND THE IRE SHOW, BE SURE TO SEE THE TYPE 502 AT TEKTRONIX BOOTHS 3027 TO 3030.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

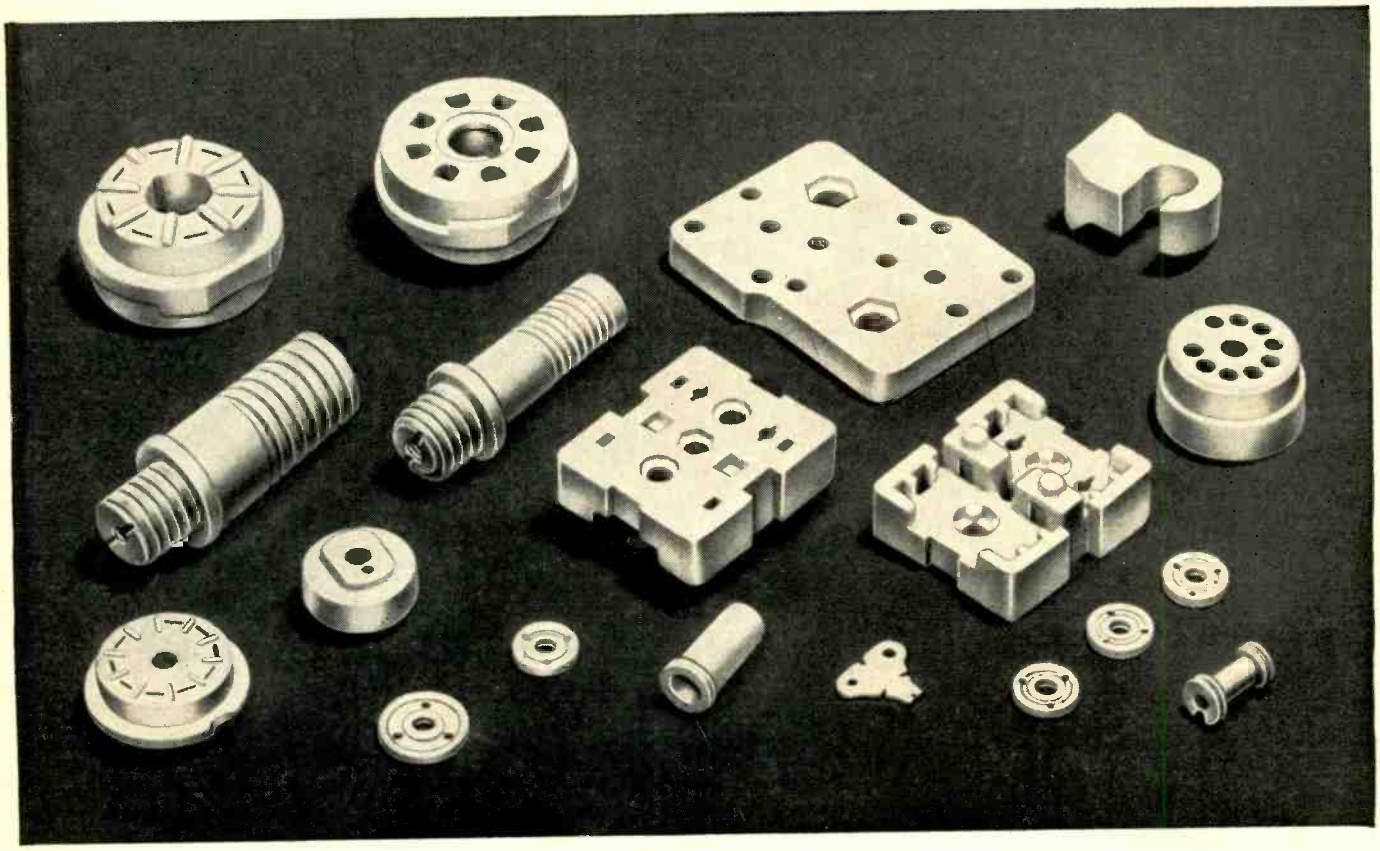
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

Regular shipments of the Type 502 are expected to begin during June, 1958. However, your Tektronix Field Engineer or Representative quite likely will be able to arrange a demonstration somewhat sooner. Please keep in touch with him for current details. If you don't know where to find him, a postcard to the factory will get you that information along with complete specifications on the Type 502.



No. 1 solution to dielectric problems–

PRECISION STEATITE by GENERAL CERAMICS



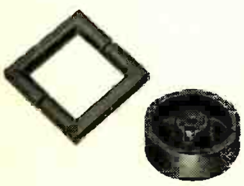
G-C steatite solves all of these problems...economically

- Widely varying ambient temperature
- Severe mechanical or thermal shock
- Permanence of dimensional accuracy
- Intricate shapes to close tolerance
- Efficient compaction of physical size
- Low electrical loss at high frequency
- High dielectric and mechanical strength
- Extreme immunity to environmental conditions

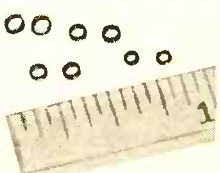
G-C electrical ceramics are news! Offering a far higher degree of dimensional accuracy than ever before possible, *precision* dielectrics provide a far greater design latitude in all types of electronic and electrical equipment. These new high accuracy ceramics are another example of General Ceramics progressive manufacture . . . better products at lower cost through advanced research and improved methods of production. Why not ask for all the facts on *precision* electrical ceramics, now! Write General Ceramics Corporation, Keasbey, New Jersey, Dept. E.

GENERAL CERAMICS

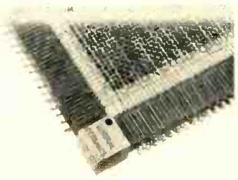
Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES

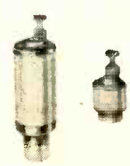


FERRAMIC MAGNETIC CORES



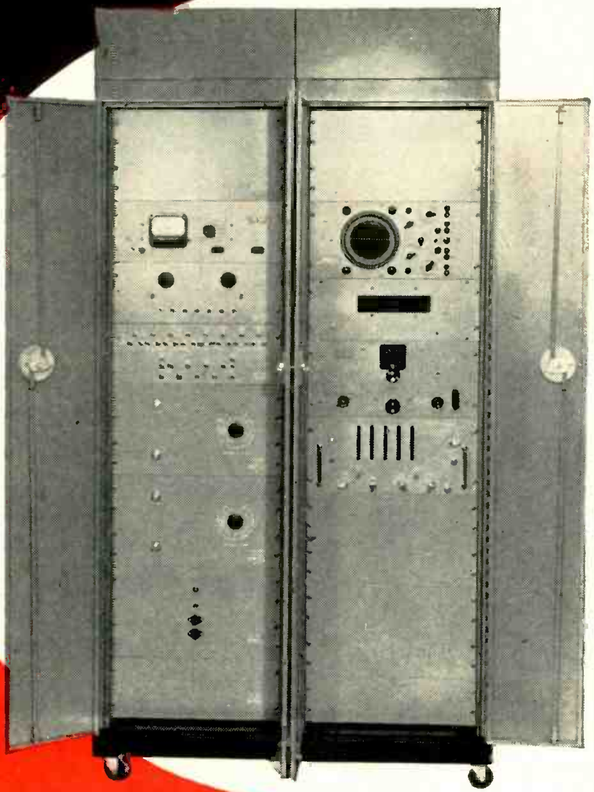
MAGNETIC MEMORY PLANES

"ADVAC" HIGH TEMPERATURE SEALS



SOLDERSEAL TERMINALS

NOW . . . FROM *Bendix-Pacific*



ADVANCED TELEMETER RECEIVING STATIONS

Bendix-Pacific, with world-wide sales rights to the entire Epsco line of telemeter receiving station equipment, is now headquarters for all advanced FM/FM equipment — ground and airborne systems and components for transmitting, receiving and recording.

The new Bendix-Pacific* Receiving Station equipment incorporates an advanced discriminator and associated equipment design. It is characterized by superior performance with virtual elimination of tuning knobs and screwdriver adjustment.

Bendix*
PACIFIC DIVISION
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

For complete information check the items below in which you are interested and mail this advertisement to us. Competent Sales Engineers are available to discuss your particular requirements in detail.

BANDSWITCHING SUBCARRIER DISCRIMINATOR operating on any IRIG frequency.	**WOW AND FLUTTER SYSTEM** for tape recording installations.	**SECONDARY STANDARD VOLTAGE SOURCE**
DUAL-CHANNEL UNIT WITH TWO DISCRIMINATORS for operation on all standard predetermined frequencies.	**PDM-TO-VOLTAGE CONVERTER** for use in data-processing systems.	**ALL-CHANNEL SUBCARRIER OSCILLATOR** for precision testing.
BAND PASS AND LOW PASS FILTERS	**PDM-TO-DIGITAL CONVERTER** for use with digital data systems.	**TRANSMITTING COMPONENTS AND SYSTEMS**

*REG. U.S. PAT. OFF.

East Coast Office: P. O. Box 391, Wilton, Conn. • Dayton, Ohio: 120 W. 2nd St. • Washington, D.C.: Suite 803, 1701 "K" St., N. W.
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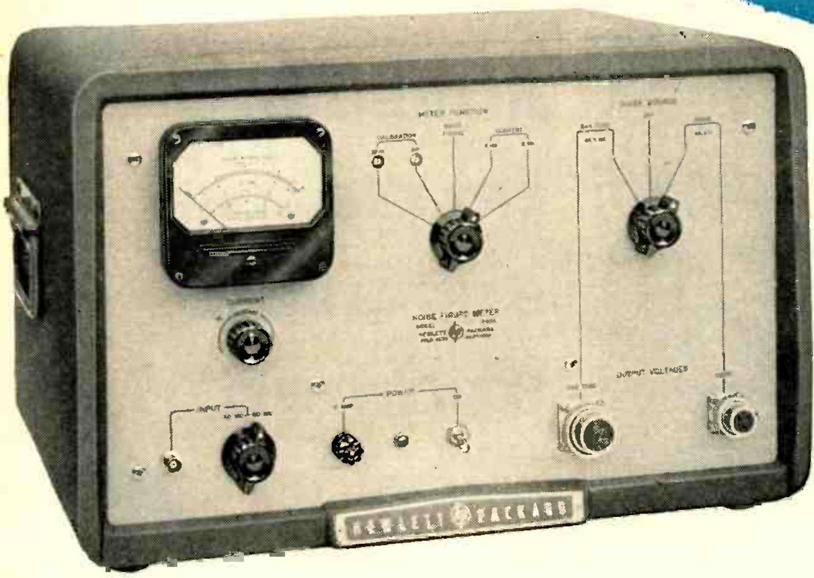
in 5



New! *-hp-* 340A NOISE FIGURE METER

Direct reading in db

Select components for minimum noise

Simple to operate; no periodic recalibration

Fast response, ideal for recorder operation

Receiver and component alignment jobs that once took skilled engineers a full hour are now done in 5 minutes by a semi-skilled worker. Receiver performance can often be improved up to 3 db over the best adjustment previously possible. Improvement in receiver performance frequently equals doubling transmitter output. Since accurate alignment is easy, equipment is better maintained and peak performance enjoyed regularly . . . *these are time saving, cost saving advantages you enjoy immediately with the new -hp- noise figure measuring equipment.*

SPECIFICATIONS *-hp-* 340A NOISE FIGURE METER

Frequency Range: Depends on noise source used.

Noise Figure Range: 3 to 30 db indication to ∞ with Waveguide Noise Source.
0 to 15 db indication to ∞ with IF Noise Source.

Accuracy: ±0.5 db, 15 to 25 db; ±1 db, 3 to 30 db with Waveguide Noise Source.
±0.5 db, 5 to 15 db; ±1 db, 0 to 15 db with IF Noise Source.

Required Receiver or rf Amplifier Gain: Approximately 40 db.

Input Frequency: 30 or 60 MC, selected by switch.

Bandwidth: 1 MC minimum.

Input Impedance: 50 ohms.

Power Input: 115/230 volts ±10%, 50/60 cps, 320 watts.

Power Output: Sufficient to operate -hp- 347A Waveguide Noise Source or -hp- 345A IF Noise Source.

Weight: Cabinet Mount: Net 40 lbs., Shipping 63 lbs.
Rack Mount: Net 35 lbs., Shipping 74 lbs.

Dimensions: Cabinet Mount: 20½" wide, 12½" high, 14¼" deep.
Rack Mount: 19" wide, 10½" high, 13½" deep behind panel.

Price: (Cabinet Mount) $715.00. (Rack Mount) $700.00.

Data subject to change without notice. Prices f.o.b. factory.

hp world leader in design and manufacture

CIRCLE 16 READERS SERVICE CARD

minutes

optimize receiver performance, measure noise figure directly!

Operating procedure

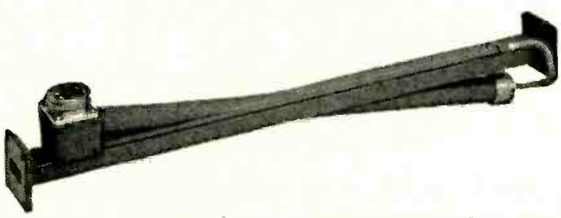
The new *-hp-* 340A Noise Figure Meter operates over any frequency range for which there are suitable noise sources. It is automatic and requires no periodic recalibration. A provision for self-check calibration is built in.

In operation, a noise source such as a gas discharge tube is connected to the input of the receiver. The receiver IF amplifier output — either 30 or 60 MC — is connected to the 340A. The 340A pulses the gas discharge tube and when the tube is fired the noise level measured is that of the receiver *plus* the discharge tube. When the tube is not being fired, noise level is that of the receiver and its termination. The *-hp-* 340A automatically compares these two conditions and presents the noise figure of the receiver directly in db on a front panel meter. Rate of response is fast so changes in receiver noise figure are instantly reflected on the 340A meter. (See *-hp-* Journal, Vol. 9, No. 5 for discussion of the importance of noise figure in measurement of performance.)

Many different uses

In addition to its remarkable time-saving convenience in optimizing receiver and amplifier performance, the *-hp-* 340A is extremely helpful in designing circuit components such as IF amplifiers, crystal mixing circuits, etc. The 340A may also be used in designing tubes, particularly wide band traveling wave tubes.

NEW -hp- NOISE SOURCES



NEW! -hp- 347A Waveguide Noise Source— These new devices, Argon gas discharge tubes mounted across a section of waveguide, are available for all frequencies 2.6 to 18.0 KMC. The Sources provide a uniform noise level throughout their frequency range with a maximum SWR of 1.2 even when the noise source is cold. No temperature correction is required.

SPECIFICATIONS

	S347A	G347A	J347A	H347A	X347A	P347A
Range, KMC:	2.6-3.95	3.95-5.85	5.3-8.2	7.05-10	8.2-12.4	12.4-18
Excess Noise, db:	15.25 ±.2	15.2 ±.5	15.2 ±.5	15.2 ±.5	15.2 ±.5	15.2 ±.5
SWR: ON and OFF	1.2 maximum; less than 1.1 average					
Approx. Length:	24″	20″	20″	16¾″	14¾″	14¾″
Price:	$190.00	190.00	180.00	180.00	180.00	180.00

NEW! -hp- 345A IF Noise Source—Designed specifically for IF amplifier noise measurement, these temperature-limited diode sources operate at either 30 or 60 MC. They will match any impedance from 50 to 400 ohms. Noise level depends on cathode current, which is controlled and metered by *-hp-* 340A Noise Figure Meter.

SPECIFICATIONS

Center Frequency: 30 or 60 MC, selected by switch.

Source Impedance: Depends on internal resistor installed.
50, 100, 200 and 400 ohm resistors supplied with instrument.

Input Power: Supplied by -hp- 340A.

Price: $75.00.

HEWLETT-PACKARD COMPANY

4644A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE HEWPACK • DAVENPORT 5-4451
Field Representatives in all Principal Areas

-hp- at IRE...top of escalators as you enter show

of electronic test instruments

APPROVED
RADIO INTERFERENCE
FIELD INTENSITY
MEASURING EQUIPMENT

STODDART designed and manufactured to Military Equipment Specifications to meet the requirements of Military Measurement Specifications.

APPROVAL DATA

STODDART & MILITARY TYPE	FREQUENCY	MIL-I-16910 (Ships)	MIL-I-6181	S.A.E.	A.S.A.	C.I.S.P.R.
NM-40A (AN/URM-41)	30cps-15Kc	CLASS '1'	Not Req'd	Not Req'd	Not Req'd	Not Req'd
NM-10A (AN/URM-6B)	14Kc-250Kc	CLASS '1'	Not Req'd	Not Req'd	C63.2 (Proposed)	Not Req'd
NM-20B (AN/PRM-1A)	150Kc-25Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.2 (Proposed)	**
NM-30A (AN/URM-47)	20Mc-400Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	APPROVED	C63.3 (Proposed)	**
NM-50A (AN/URM-17)	375Mc-1000Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.3 (Proposed)	Not Req'd

**MIL-I-6181C (Proposed)*
***Can be supplied to C.I.S.P.R. Recommendations*
S.A.E. (Society of Automotive Engineers)
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C.I.S.P.R. (Comite International Special des Perturbations Radioelectriques) (International Special Committee on Radio Interference)

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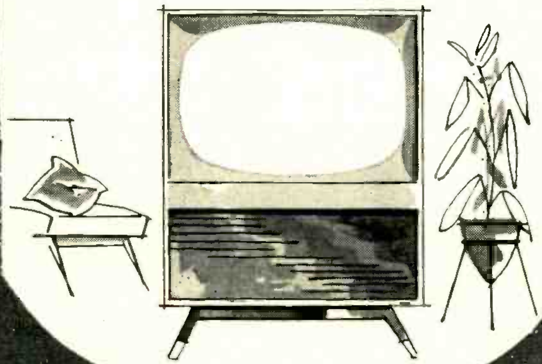

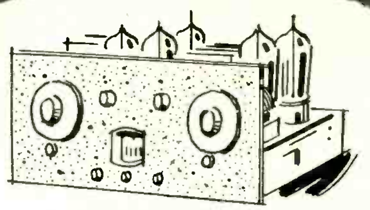

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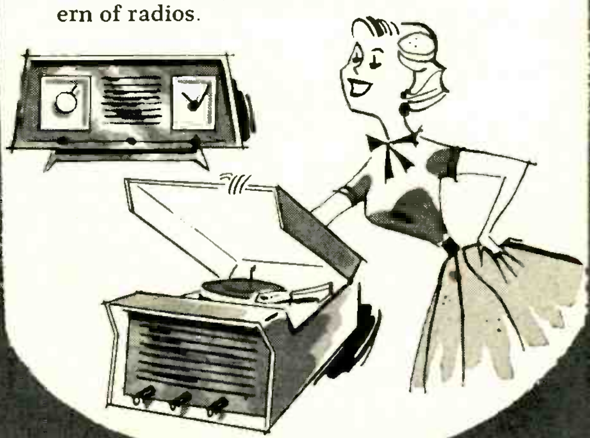

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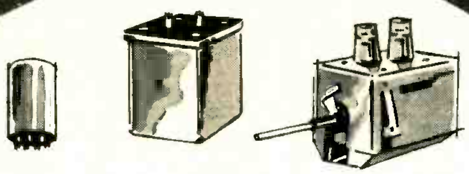

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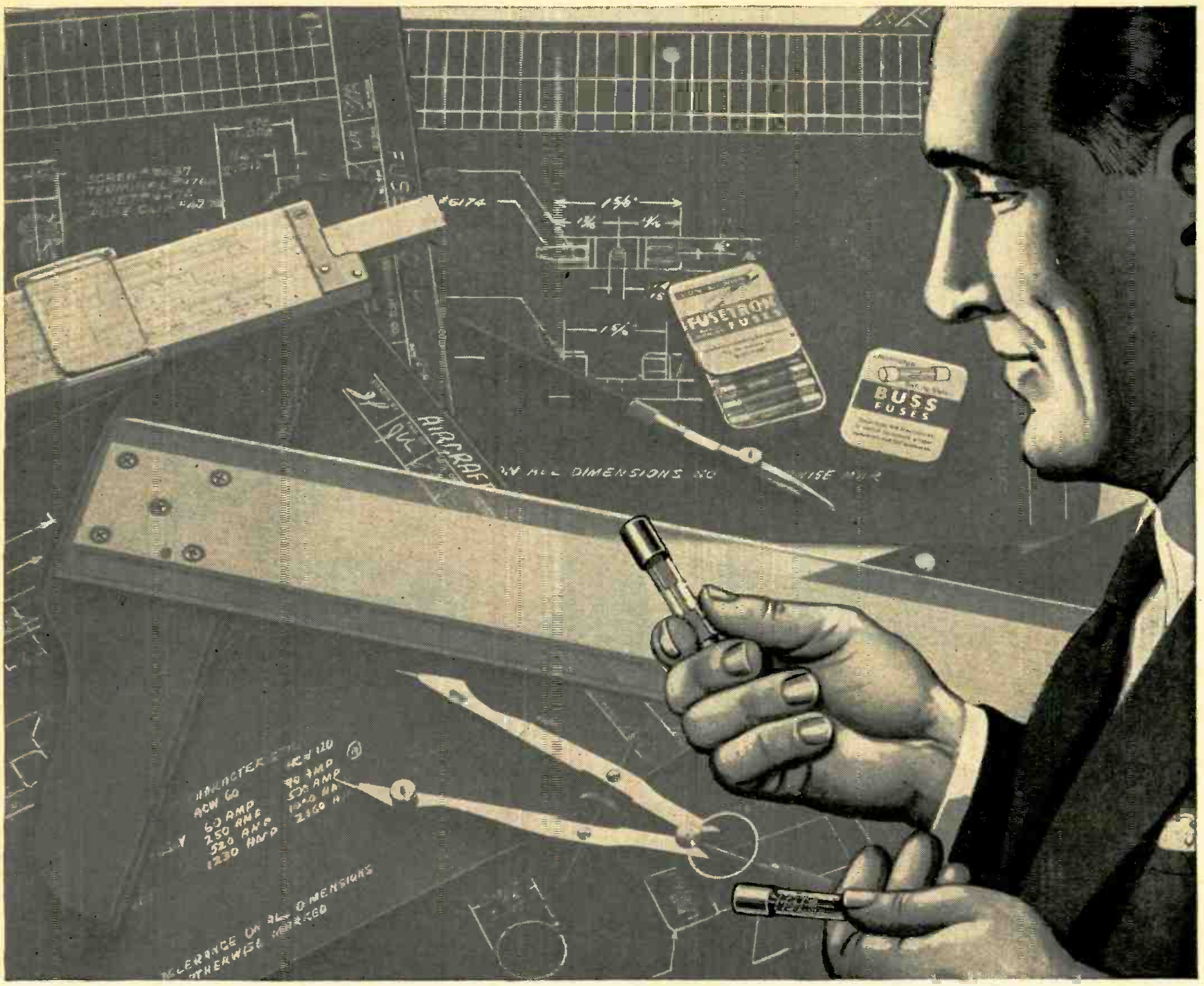

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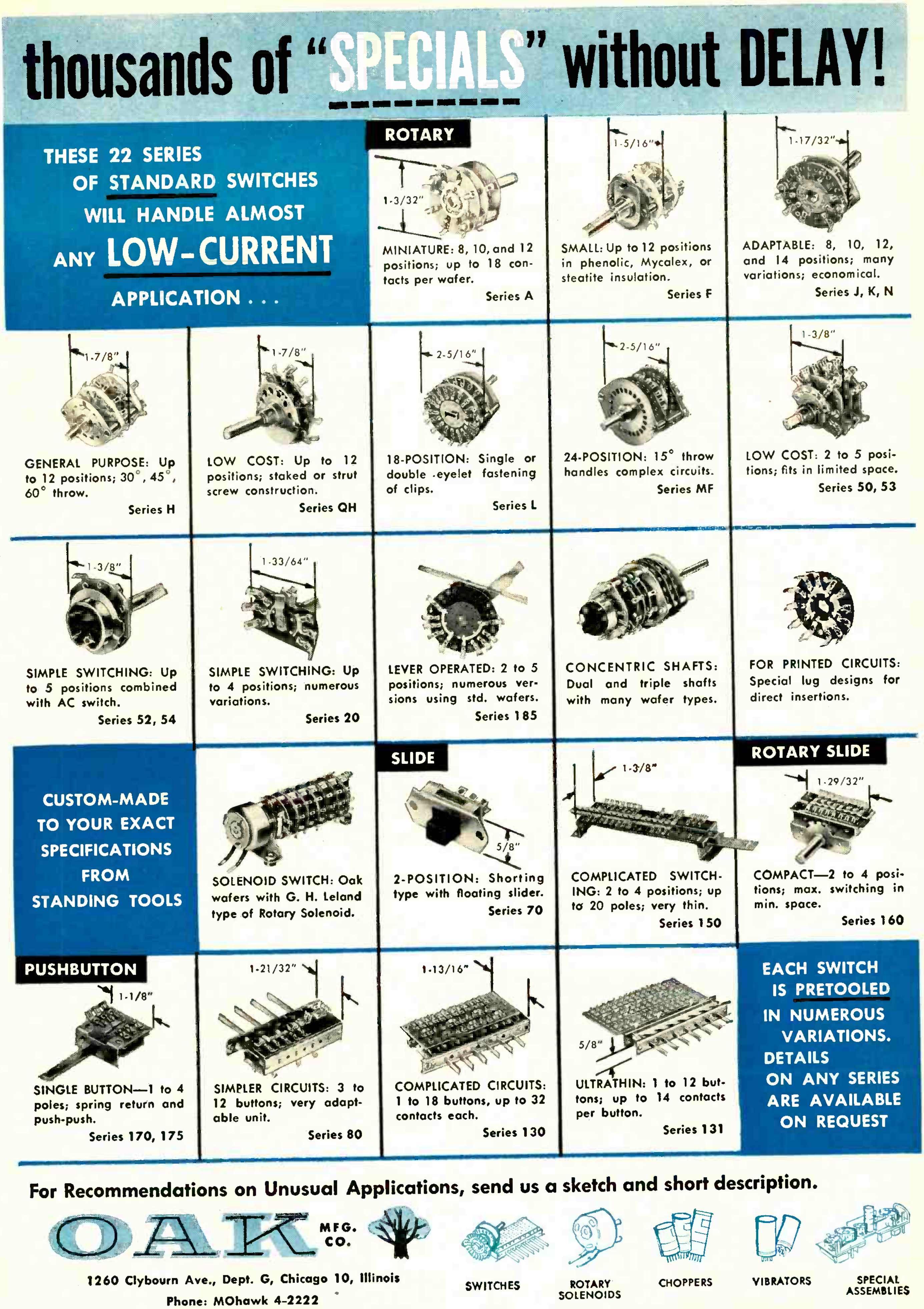
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More and more electronics manufacturers throughout the country are using Jones & Lamson Optical Comparators in their quality control operations. Small shops, as well as the giants, have learned that a J&L Comparator pays for itself in very short order.

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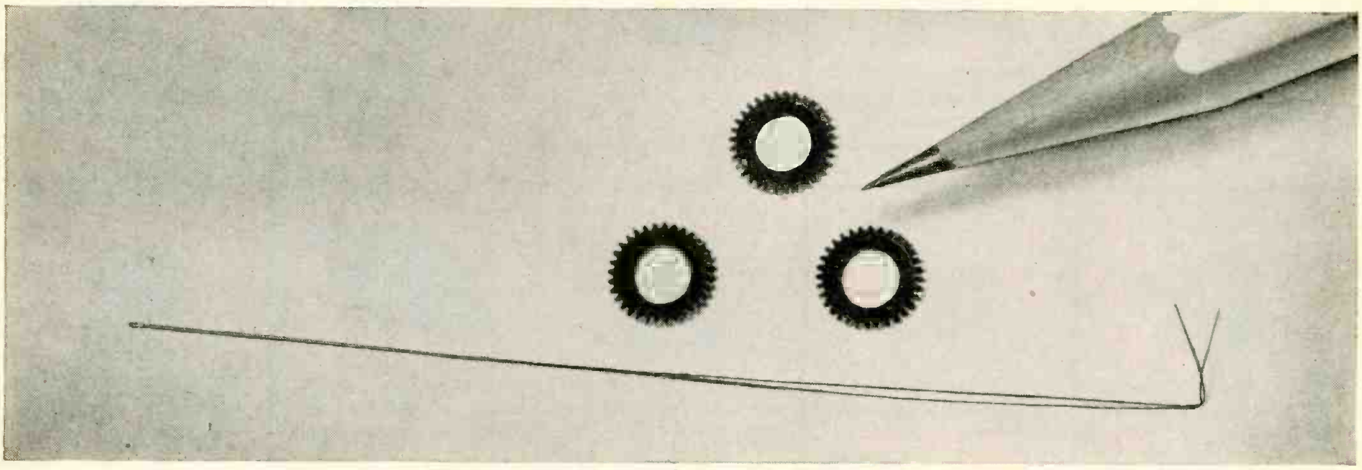
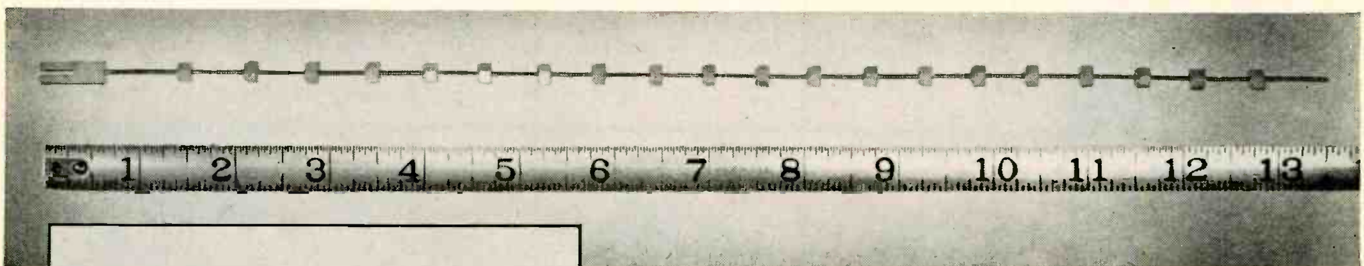
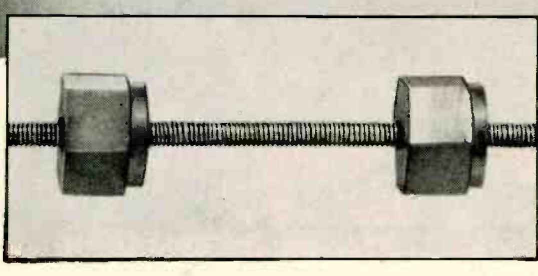
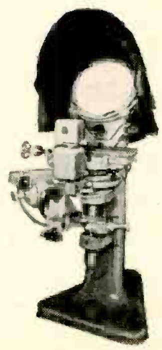


For Instance — A customer writes: "One of our assemblies, containing 32 separate circuits, measures only 5/16" dia. by 1" long. The parts which go into this assembly must have perfect shape and tension, which are impossible to check by mechanical means. Two such parts are these .005" dia. gold wires, and precisely toothed brush spacers. Since using the J&L Optical Comparator in our inspection, assembly failure due to malfunction of either of these two parts has virtually disappeared."





This precisely-threaded rod (used in calculating machines) is of .047" dia. stock, 120 pitch, with continuous threading along its entire 12" length. Threading accuracy and critical dimensions are measured and checked speedily and efficiently with a J&L Comparator.



Model PC-14

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You're precisely correct

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Fenwal Thermistor Temperature Controllers

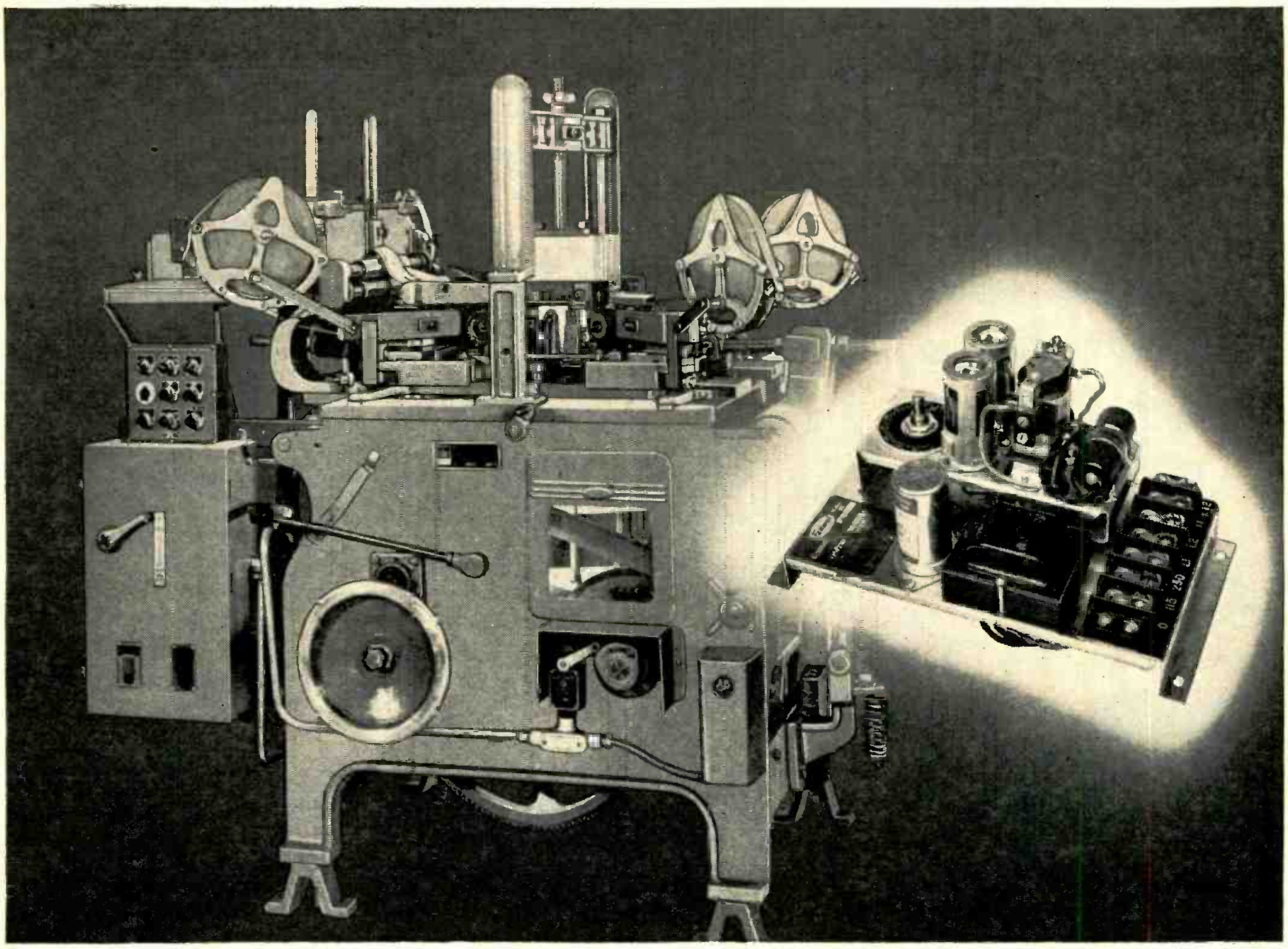
When we say "precisely" we mean control within .25% of range! Here's why — when temperature goes up, the resistance of the thermistor sensing element goes down — a unique property that makes very small temperature changes into large resistance changes. That means *quick, extremely precise temperature control!*

Small probes respond fast — can be installed nearly anywhere. Unbalanced bridge circuit design assures sensitivity and reliability. These are among reasons why one Thermistor Controller customer can report 0.08°F control. Why another reports over two years service with *no drift or set point variation!*

You can have remote control — as much as 200 feet — without ambient or lead length compensation problems. You can control 1 or 100 points, with or without indication. Versatile Fenwal Thermistor Controllers are adaptable to all kinds of applications. No matter what your need, you get *dependable precision with amazing stability.*

You'll want to have complete details on the new advance in precision temperature control at your fingertips, and we'll get it in your hands soon if you'll write us at Fenwal Incorporated, 202 Pleasant Street, Ashland, Massachusetts.

Here's a Thermistor Controller (Model 530) in a package forming machine. One Fenwal Thermistor probe in one corner plunger controls temperature at all four corners. A potentiometer on the control panel permits infinitely variable temperature range from 200 to 600 degrees. It eliminates a thermostat in each of the corner plungers, simplifies operation and maintenance — and assures uniformly high quality output. There are four standard temperature ranges for you to choose from: −100°F to 50°F; 0°F to 150°F; 100°F to 300°F; and 200°F to 600°F. Special ranges can, of course, be supplied in most cases.



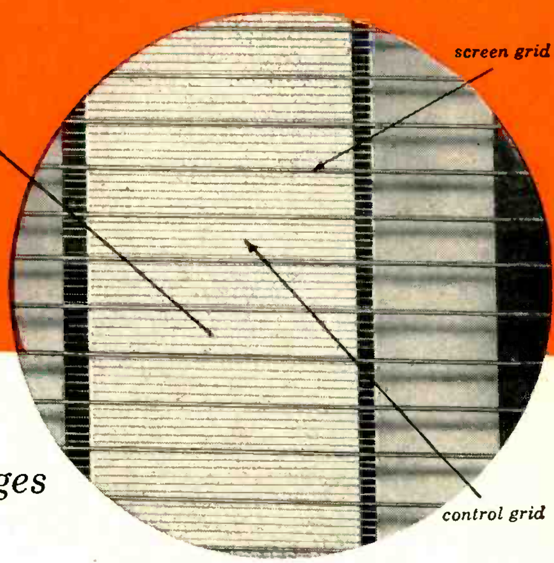
Fenwal CONTROLS TEMPERATURE . . . PRECISELY

no other transmitting tube but the

Amperex® 6939

gives you

5.5 watts useful power in load (ICAS) up to 500 Mc at maximum ratings in a miniature envelope



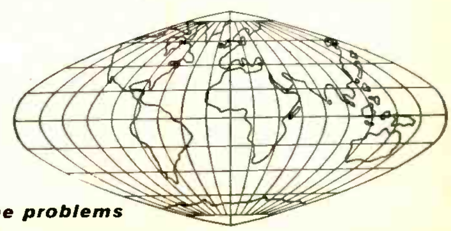
unsurpassed for low-power UHF transmitter applications . . . saves entire stages in original equipment design

AMPLIFIER, CLASS C, FM	*Operating Conditions*	
	C.C.S.	I.C.A.S.
Frequency	500 Mc/s	500 Mc/s
Plate Voltage	180 V	200 V
Screen Grid Voltage	180 V	200 V
Control Grid Bias	–20 V	–20 V
Plate Current	2x27.5 mA	2x30 mA
Screen Grid Current	11 mA	13 mA
Control Grid Current	2x1 mA	2x1 mA
Driving Power	1.0 W	1.0 W
Plate Input Power	2x5 W	2x6 W
Plate Dissipation	2x2.1 W	2x2.25 W
Screen Grid Dissipation	2 W	2.6 W
Output Power	5.8 W	7.5 W
Useful Power in Load	4.5 W	5.5 W

The Amperex 'FRAME-GRID' CONSTRUCTION insures extreme accuracy of interelectrode spacing, the secret of the 6939's brilliant performance. The relatively massive metal frame acts as a heat-sink, safely limiting control-grid temperature.

Write for detailed data sheets to Communications Tube Division, Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, L. I., New York.

ask Amperex



...for applications engineering assistance on your communications tube problems

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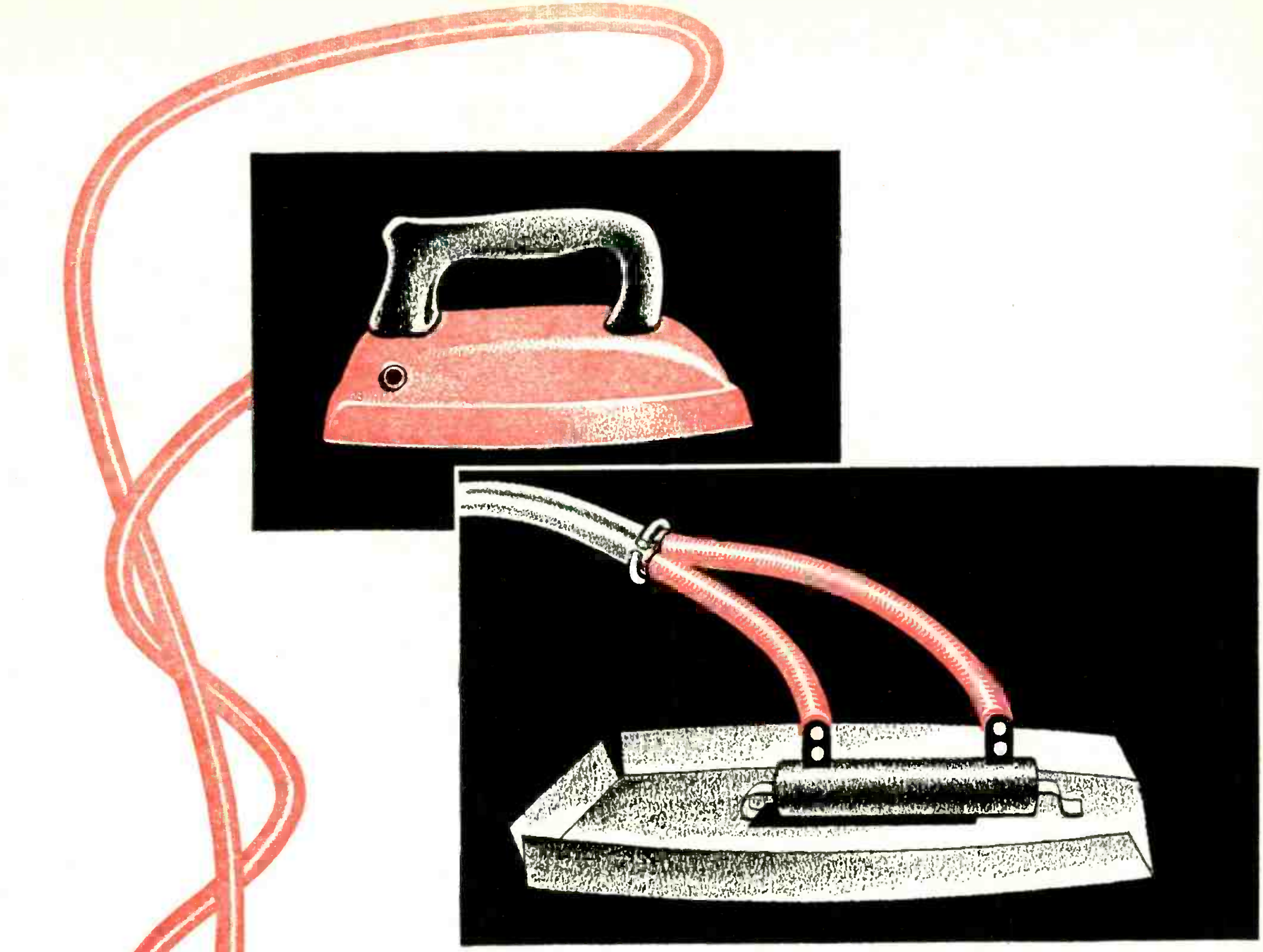

STAYS flexible under heat

Heat won't faze this toy iron — the lead wires have been *permanently heat-proofed* with BH Ex-Flex fiber glass Sleeving . . . to provide the supplementary insulation required by Underwriters' Laboratories.

As supplementary protection and as a primary insulation for low voltage circuits, BH Ex-Flex offers permanent flexibility, permanent roundness, permanent heat resistance.

Inadequate insulation can shorten the life of even the finest product. In the BH line, of tubing and sleeving, you will find the correct answer to many insulation problems. Send us a few facts on temperature, working conditions, etc., and we'll send you samples of the most efficient insulation for your application. Catalog on request.

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50 ohm Coax Terminations dc to 4 KMC!

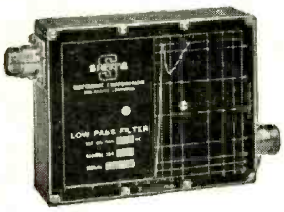
8 new instruments!
1 to 500 watts coverage!

New Sierra 160 series Coaxial Terminations are ideal for use with directional couplers, or in other applications requiring wide frequency range and low VSWR. They provide extremely high stability, and will dissipate full rated power continuously up to an ambient temperature of 40°C. Derating permits operating at still greater ambient temperatures. Terminations are completely shielded, and may be used to adjust transmitters without radiation. They are also useful for converting Sierra Bi-Directional Power Monitors to a termination type wattmeter.

SPECIFICATIONS

Model	Power*	Connectors	VSWR
160-1F	1 watt	Type N fem.	Less than 1.10, dc to 4 KMC.
160-1M	1 watt	Type N male	
160-5F	5 watts	Type N fem.	Less than 1.08, dc to 4 KMC.
160-5M	5 watts	Type N male	
160-20F	20 watts	Type N fem.	Less than 1.10, dc to 1 KMC;
160-20M	20 watts	Type N male	Less than 1.15, up to 4 KMC.
160-100F	100 watts	Type N fem.	Less than 1.2, dc to 4000 MC.
160-500F	500 watts	Type N fem.	Less than 1.2, dc to 3400 MC.

*Up to 40° C ambient.



New LOW PASS FILTERS

Sierra 184 series Low Pass Filters have an insertion loss not more than 0.4 db in pass band, sharp cut-off, 1.5 VSWR or less, and rejection greater than 60 db from 1.25 to 10 times cut-off frequency. Five models: for cut-off frequencies of 44, 76, 135, 230, 400 MC. Power range 250 watts in pass band, 25 watts in rejection band.

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See this equipment IRE SHOW Booths 3905-3907

WIDEBAND DIRECTIONAL COUPLERS

Versatile, accurate Sierra couplers are offered in 6 models for frequencies 10 kc to 2000 mc. Couplers provide transmission line measurements including reflection coefficient, VSWR, power. Also permit matching of loads to lines dynamically by indicating conditions providing minimization of reflected voltages. Request Bulletins 101, 104.

Coupling Factor: (in db ± 1 db)

Model	10 kc	3 mc	10 mc	30 mc	100 mc	300 mc	1000 mc	2000 mc
137, 137A				73	63	53	43	37
138, 138A				59	49	39	29	
145		52	42	32	22	12		
150				53	43	33	23	
139	50	50						

Directivity: 12 db ± 3 db greater than coupling factor at each frequency.
Impedance: Models 137 and 138 are 51.5 ohms. Models 137A, 138A, 145 and 150 are 50.0 ohms. Model 139 may be matched to most impedances.
Power: Usable to 1000 watts throughout frequency range.

SIERRA 148 CRYSTAL DETECTOR

Insures sensitive readout for Sierra Directional Couplers. Low VSWR, high sensitivity to 1200 MC. 50 ohm input impedance, filtered output. Type N input, BNC output connectors.

3663-R

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CANADA: Atlas Radio Corp., Ltd., Toronto, Montreal, Vancouver, Winnipeg

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How Research Shapes Our Future Prosperity

If you are looking for an industry that is going to keep on booming in 1958 and every year for the next decade, here it is. It is the industry of technological innovation through research and development.

Last year this great new industry spent over $7 billion to discover and develop new industrial products, processes and equipment. This year the preliminary McGraw-Hill survey indicates that total expenditures for industrial research and development will be even greater, perhaps as much as $8 billion. Of the companies surveyed, 57% plan to spend as much as in 1957 and 38% plan to spend more.

The sustained expansion in research and development is the best guarantee we have that the current decline in business investment in new plants and equipment will be relatively short-lived. There can be no prolonged decline in investment in an economy where technology is changing rapidly.

This editorial is designed to show how the continued surge in research and development can be expected to lead first to new products, and eventually to renewed expansion of investment in new industrial plants and equipment. Such expansion is the essence of national economic growth.

A Slow Start

The impact of research on sales and investment is still very gradual. Research spending itself has more than doubled in the last four years. But only 32% of all manufacturing firms report significant capital outlays to make new products. We are not reaping the full dividends of industrial research as yet for several reasons:

- Research expenditures were relatively small until the Korean War of 1950 brought substantial government contracts in aviation, electronic and related fields. Heavy research outlays for civilian and industrial products came even later.
- There is an average *lag*, according to research directors consulted by the McGraw-Hill Department of Economics, of roughly seven years from the start of research until the product is ready for large scale output — about five years of research and at least two years to solve production problems and develop markets.
- Complex products, such as new consumer durables and industrial machinery, have an even longer time lag.

However, new developments are certainly underway. Research began to increase in all lines of business when Korean War restrictions and the excess profits tax came to an end in 1953. The tax revision of 1954 added a new incentive by making research outlays deductible as a current business expense. By 1955, the research boom was on.

When Is The Payoff?

With a lag of about seven years, it will be the early 1960s before these new developments become a dominant factor in capital investment. But once the flow of new products and new processes starts, it will accelerate sharply — just as research spending has accelerated in the past few years.

By 1960, over $50 billion in sales will be coming from products not on the market as recently as 1956. Sales of new products will increase year by year, but they will gain most in 1960-1962, or five years after the recent spurt in research expenditures.

Capital expenditures to manufacture new products will also rise, but with a slightly longer lag. Here the sharpest rise should come in 1962-1965, as the new products reach a volume that calls for a significant amount of new capacity. In most cases, initial output of new products will come from existing capacity.

This timing of a new wave in capital investment appears logical on other grounds. Population experts forecast an upsurge in marriages and births around 1965. So by 1962, industry will be starting to tool up for new mass markets.

The important point is this: As we approach the 1960s more and more sales and investment will be in new products growing out of research. By 1960 well over 10% of manufacturing sales will be in new products not on the market in 1956.

Meanwhile — research will help stabilize capital spending by raising the level of modernization and replacement expenditures. Of course, research does not eliminate all the ups and downs in the demand for capital goods, for there remain variations in the amount spent to expand capacity. But a high level of modernization, to cut costs and improve quality, does put a floor under any drop in investment.

What To Expect

During the next few years we can expect an increasing flow of new materials, new metallic alloys, new machinery — primarily those developments coming out of long-established research programs in the chemical and electrical industries. Industry will make wider use of specialized computers and automated equipment.

But the dramatic payoff on research comes even later. In the early 1960s the consumer goods industries will begin tooling up for their really new products — things so basically new they can change the way a family lives. Such items as plastic houses, paper apparel, turbine autos are under development right now. But it will take several years to get costs down and for population and incomes to grow to the point where mass markets are created.

When we reach that point in the mid-1960s, there will begin the greatest surge of capital investment in all history. And then — around 1965 — the new processes (full automation, atomic power, continuous steel casting) which are the slowest and most expensive part of the research chain to develop, will come into play.

The combined impact of new products and new processes, to meet an expanding market, will thus be felt in the mid-1960s — eight to ten years after the recent sharp increase in research spending. The full impact is that far away because of the lags for applied research, pilot plant studies and market introduction. But to a large degree the prosperity of the 1960s has already been shaped by the research programs now underway.

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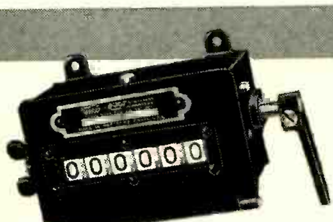

Series 1380
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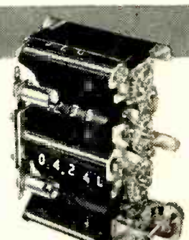
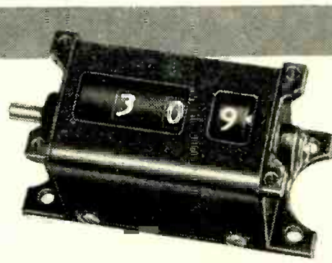


4-bank Counter for Radio Transmission Equipment



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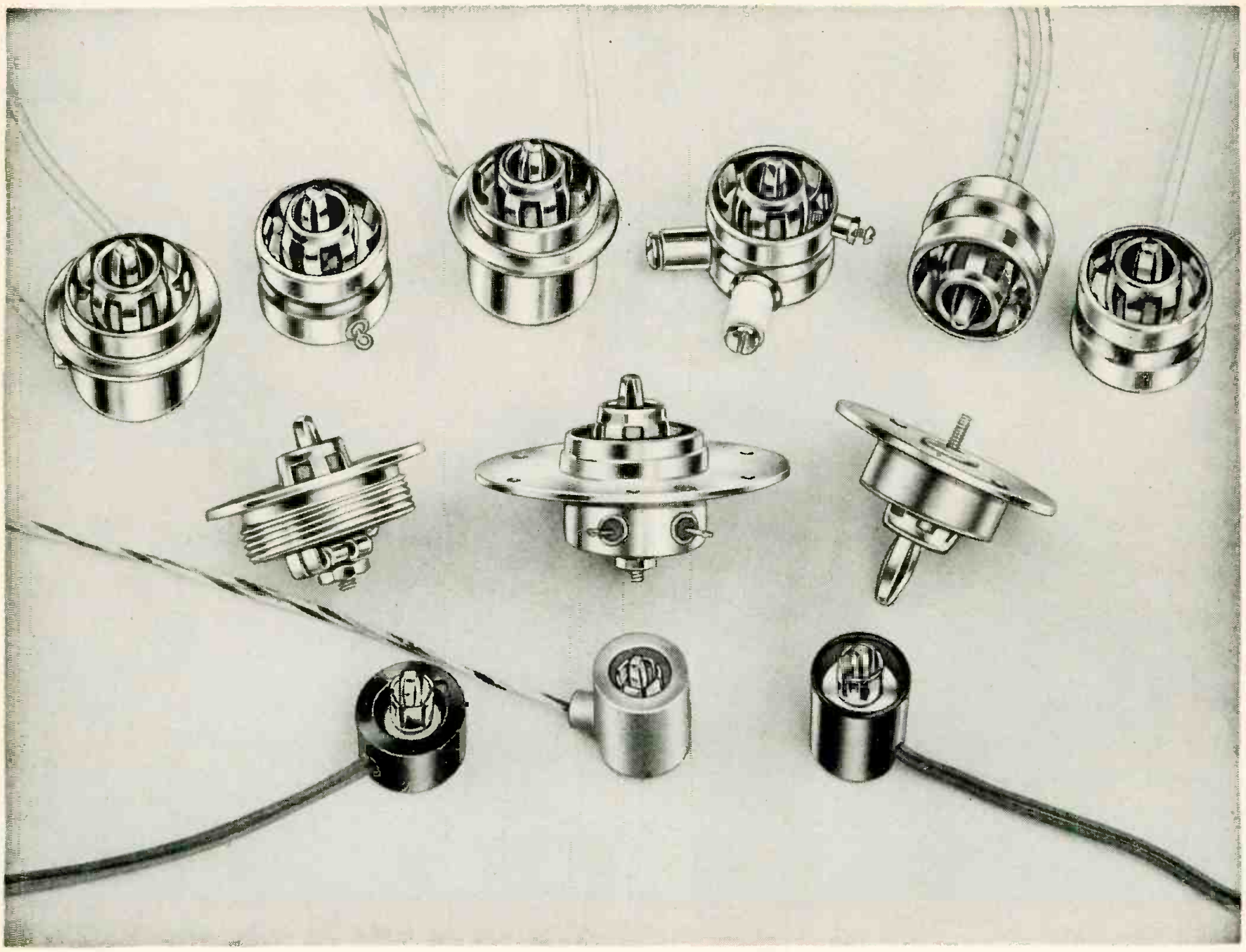

Ucinite Magnetron Connectors

Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capacitors for added protection. Connecting leads of any length can be furnished to customer's specifications.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

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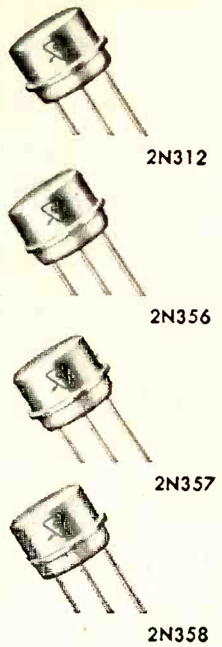

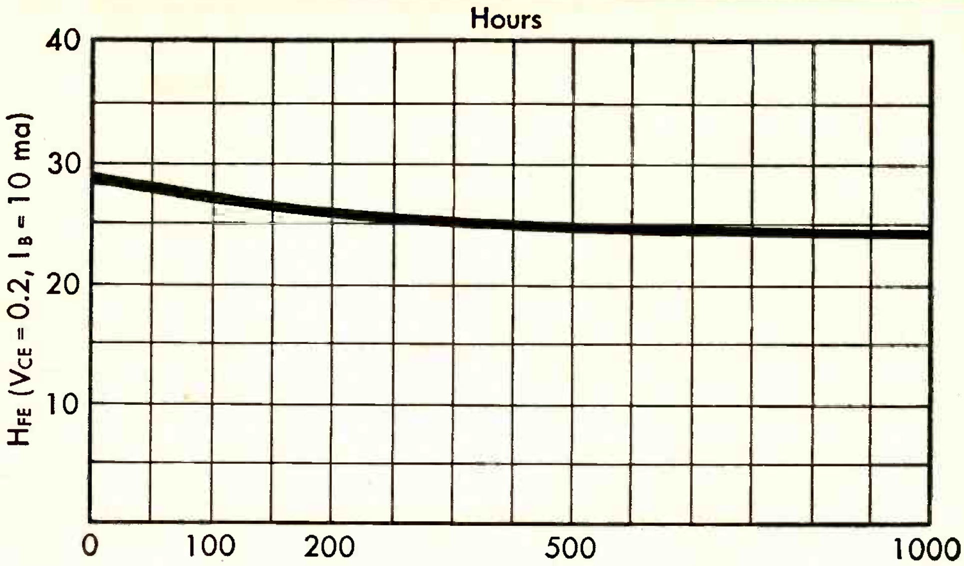

Evaluation of Sylvania transistors types 2N312, 2N356, 2N357, 2N358, for 1,000 hours at 85°C shows the high Beta stability the units maintained throughout the test.

Four more **Computer Transistors**

-from Sylvania

Sylvania widens its product line of high stability types designed especially for computer applications

Design engineers are now provided with an expanded line of computer transistors from Sylvania, basic source for high Beta units. The new additions, types 2N312, 2N356, 2N357 and 2N358, are NPN germanium alloy junction transistors. They exhibit the stable Beta characteristics and fast switching times that have made Sylvania types 2N377, 2N385 and 2N388 so popular. The new transistors are "base-off-the-can" types designed specifically for those applications where all transistor elements must be insulated from the metal case.

As with Sylvania original computer transistors, the types 2N312, 2N356, 2N357 and 2N358 meet EIA size group 30 dimensions. They also meet environmental tests typical of those required in military applications. Tests include temperature cycle, moisture resistance, centrifuge, and lead fatigue.

In addition to stable Betas at changing current levels, the four types have good leakage stability. Total dissipation for each unit is conservatively rated at 100 mw with ambient temperature at 25° C.

Typical Characteristics (25° C):	2N312	2N356	2N357	2N358
Collector Cutoff Current, I_{CBO}				
V_{CB} = 20, emitter open	—	20	20	20 ua
V_{CB} = 15, emitter open	10 ua	—	—	—
V_{CB} = 5, emitter open	—	3	3	3 ua
V_{CB} = 1, emitter open	2 ua	—	—	—
Emitter Cutoff Current, I_{EBO}				
V_{EB} = 20, collector open	—	20	20	20 ua
V_{EB} = 15, collector open	10 ua	—	—	—
V_{EB} = 5, collector open	—	3	3	3 ua
V_{EB} = 1, collector open	2 ua	—	—	—
Emitter Punch Thru, I_E				
V_{EB} = 0	—	20 (V_{CB} = 20)	20 (V_{CB} = 18)	20 ua (V_{CB} = 15)
Collector Punch Thru, I_C				
I_B = -25 ua (reverse bias)	—	500 (V_{CE} = 20)	500 (V_{CE} = 18)	500 ua (V_{CE} = 15)
R_{BE} = 10K	400 ua (V_{CE} = 15)	—	—	—
Current Gain, h_{FE}				
V_{CE} = 0.25, I_C = 100 ma	—	30	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	30	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	30
V_{CE} = 1.0, I_C = 10 ma	45	—	—	—
Saturation Voltage, V_{CE} (max.)				
I_C = 100 ma, I_B = 10 ma	—	0.2	—	—
I_C = 200 ma, I_B = 20 ma	—	—	0.2	—
I_C = 300 ma, I_B = 30 ma	—	—	—	0.2
I_C = 10 ma, I_B = 1 ma	0.075	—	—	—
Input Voltage, V_{BE} (max.)				
V_{CE} = 0.25, I_C = 100 ma	—	0.8	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	0.8	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	0.8
Rise Time	1.0	1.0	.6	.4
Storage Time	1.5	0.3	.3	.5
Fall Time	0.8	1.0	.6	.6

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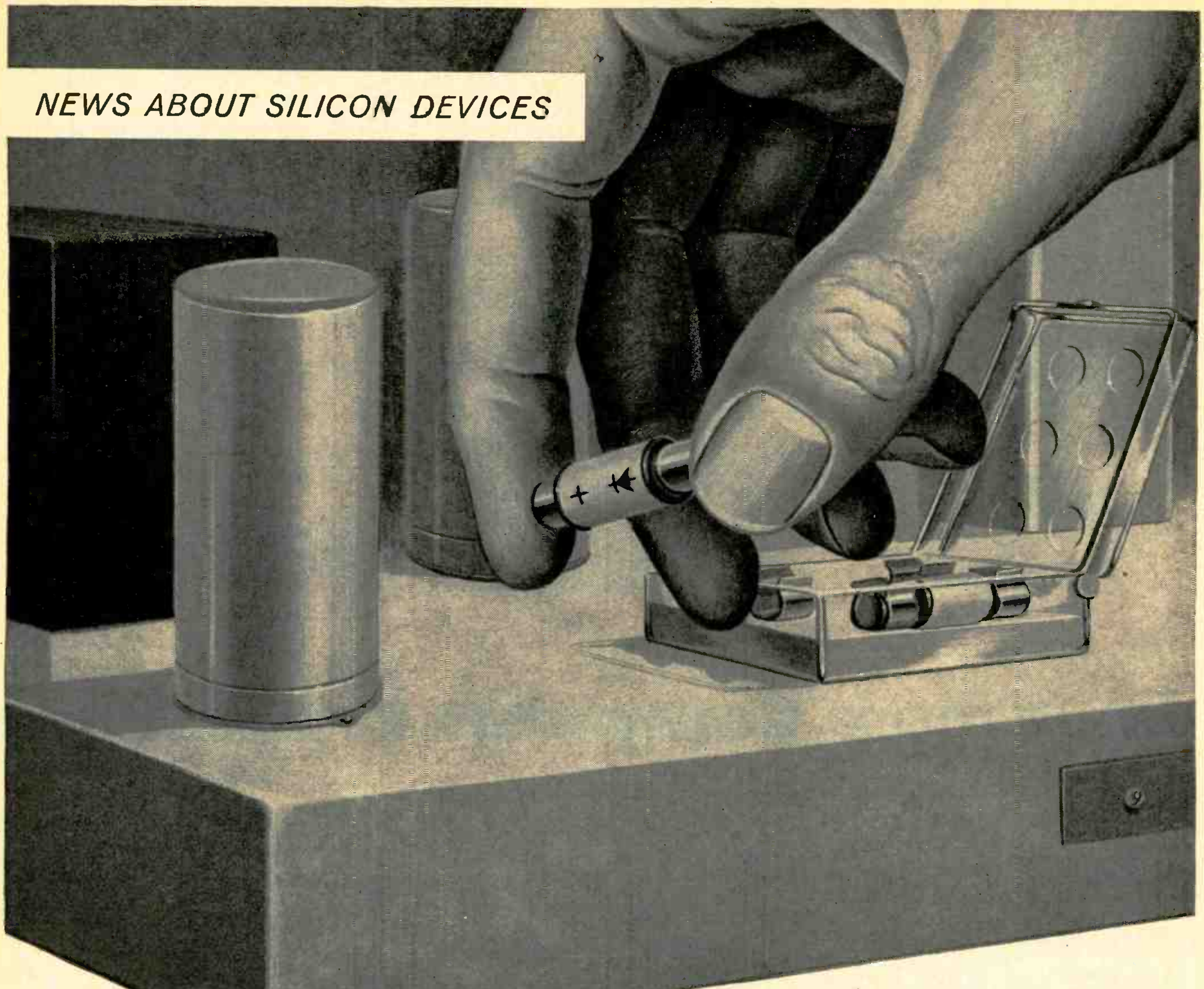

NEW SILICON DIODE, rated at 500-ma output current and 330-volt rms input voltage, is an example of the growing development in the design of components for use in TV-power supplies.

Now... more efficient power supplies for radio-TV made possible with Du Pont Hyperpure Silicon

Actual test results as reported by various manufacturers indicate important advantages of silicon diodes and rectifiers. One TV manufacturer, for example, operated samples of silicon rectifiers under load continuously for 5,000 hours—with no noticeable drop in output voltage. Another manufacturer reports no voltage change after 500 hours in 95% humidity.

Silicon-equipped sets are relatively free of a decline in B+ voltage. Silicon diodes are up to 99% efficient in units operated at 60 cps—reverse leakage is as low as a few microamperes. Both rectifiers and transistors of silicon have temperature ratings far higher than those of other semiconducting materials . . . can operate continuously at −65° to 200°C.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use . . . having a purity range of 3 to 11 atoms of boron per billion. Technical information is available on crystal growing from Du Pont . . . pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON
You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. For your copy write to: E. I. du Pont de Nemours & Co. (Inc.), Silicon N-2496-E-2, Wilmington 98, Dela. (This offer is limited to U. S. and Canada.)

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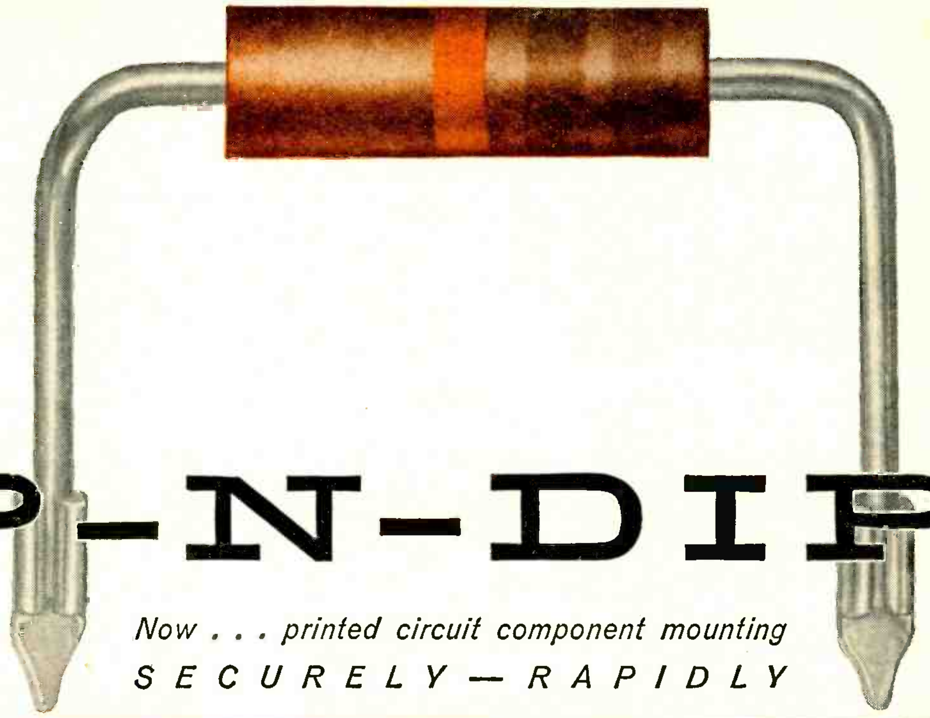
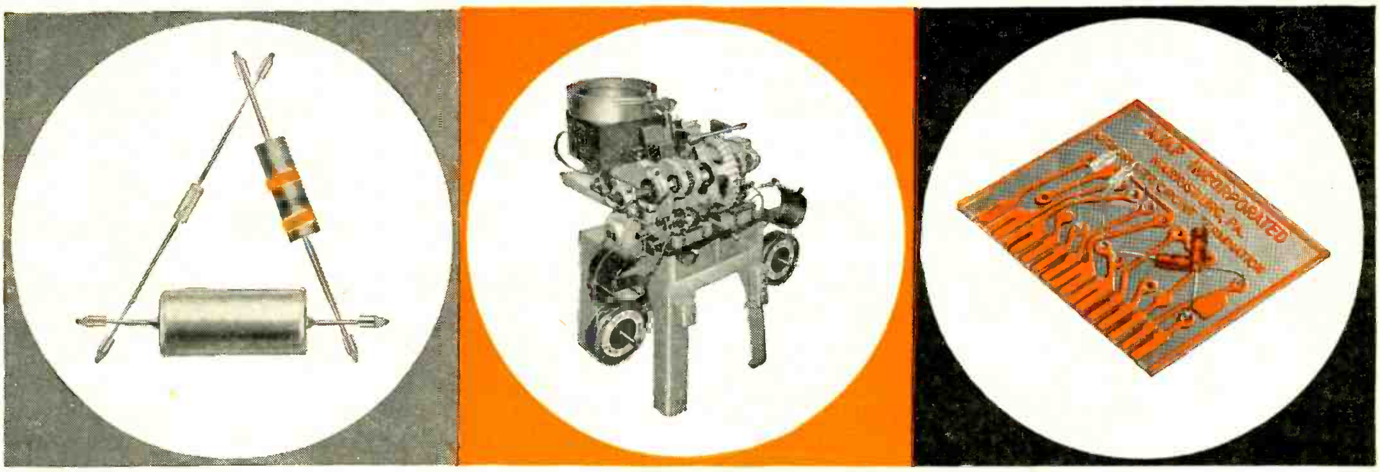


TIP-N-DIP

Now . . . printed circuit component mounting

S E C U R E L Y — R A P I D L Y



The A-MP Component Tip provides these new advantages to manufacturers using printed circuit techniques:

- eliminates the need for eyelets or thru-plating on two-sided boards
- prevents cold solder problems by eliminating any movement of the component during dipping cycle
- permits bridging or offsetting of components—for air circulation and elimination of temperature influence
- design promotes solder-wicking and uniform solder deposit
- protects fine semi-conductor leads from heat and assembly damage

AMP-engineered, high-speed, automatic tipping machines provide an easy and economical method for applying A-MP Component Tips to leads of single-piece or belted components.

Additional information is available on request.

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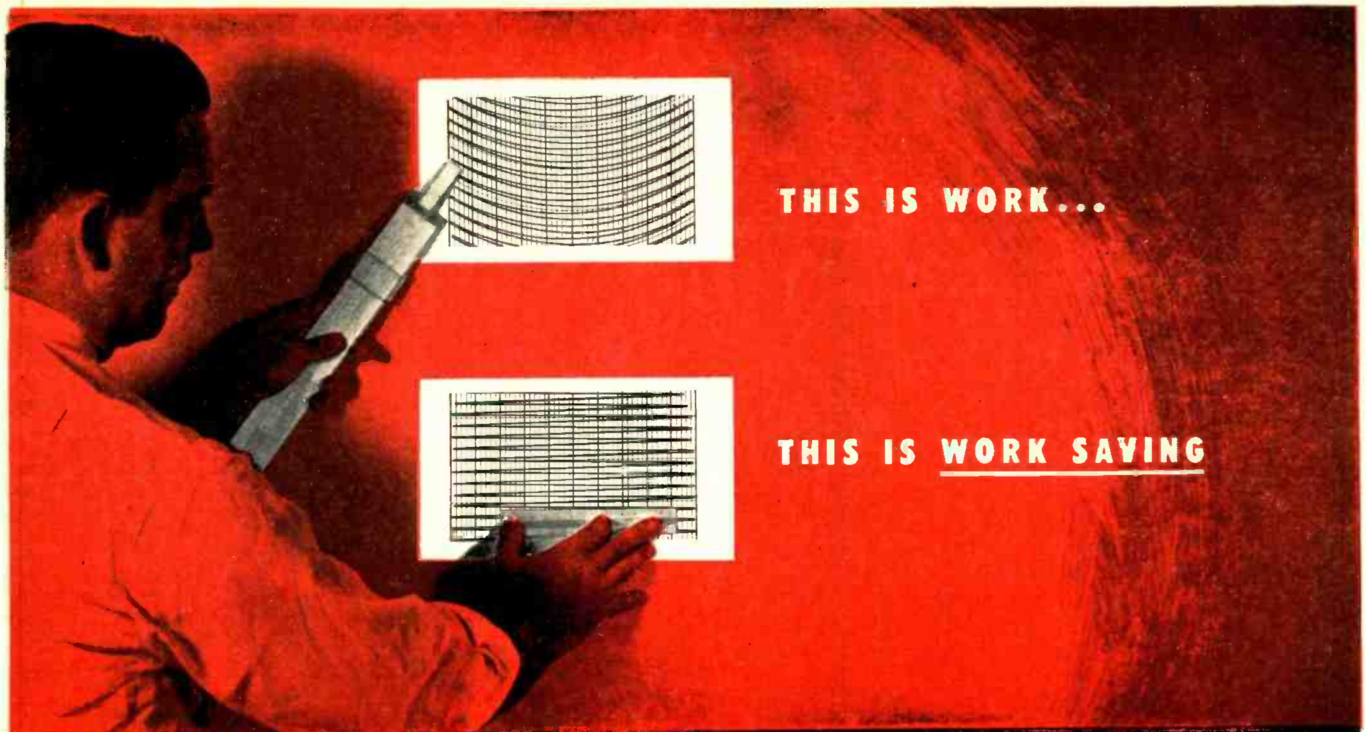

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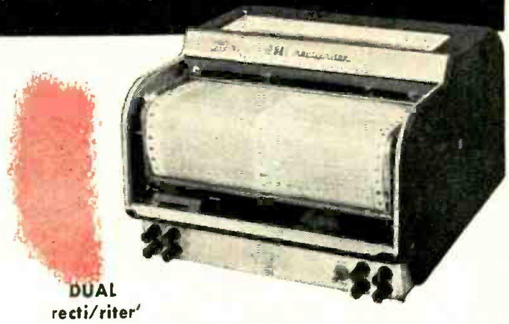
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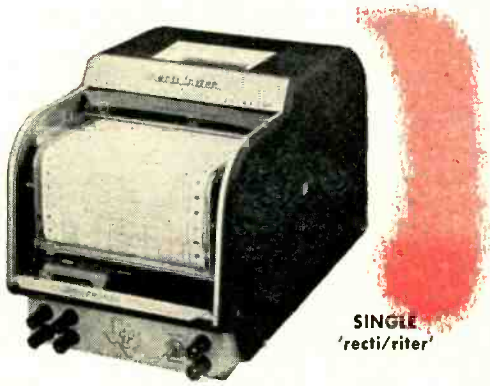
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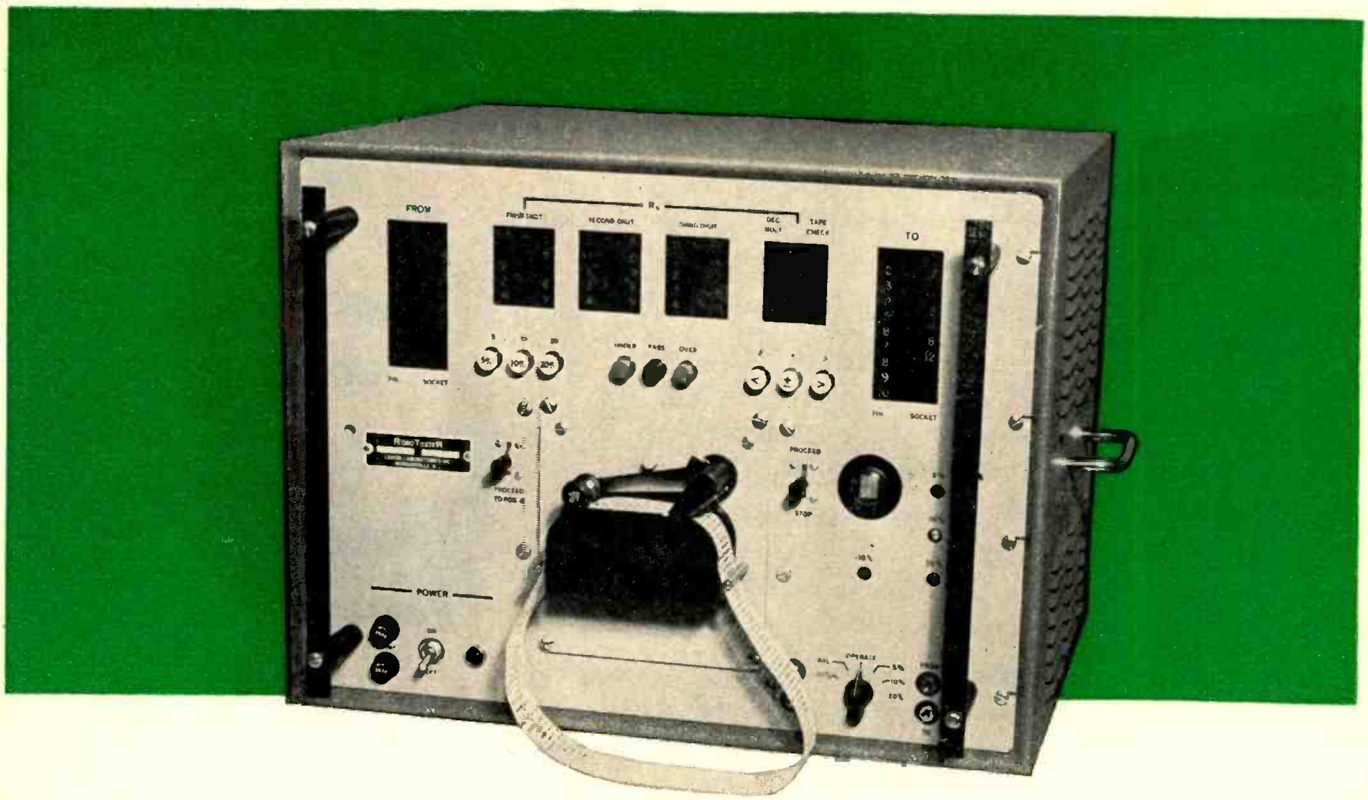
The Robotester has virtually unlimited application . . . depending upon the bounds of your imagination! For example, the Robotester can be used as a systems component, providing your equipment with internal programmed testing and function facilities. And when combined with Lavoie Robotester Accessories . . . the Roboprinter . . . this unit will provide permanent records of errors, allowing a single operator to handle several Robotesters. Other accessories lend ample support to the unit's versatility.

To see the Robotester in full action, visit the Lavoie IRE Show Booth No. 3242-43-44. Meanwhile, write for complete details.



Lavoie Laboratories, Inc.

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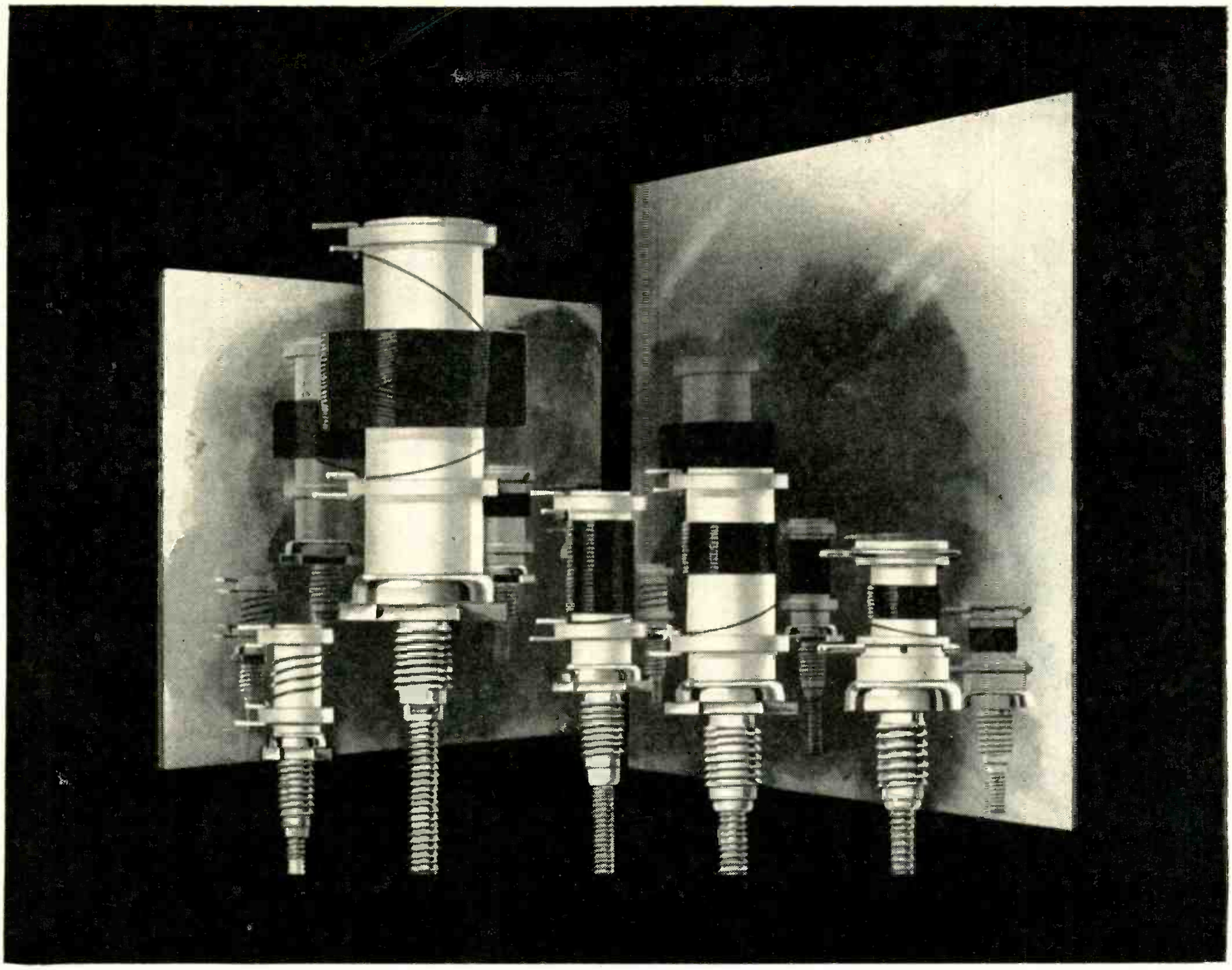
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT



Cambion® coil forms with Perma-Torq*® Tensioning Device are designated PLST, PLS-6, PLS-5, PLS-7, PLS-8 and are factory assembled to mounting studs. The units are completely interchangeable with Cambion's LST, LS-5, LS-6, LS-7 and LS-8.

Reliability is their family resemblance

Here's a reliable family of coil forms ready to meet your specifications. These Perma-Torq Tensioning Devices on Cambion coil forms allow locking of tuning cores while still tunable — and you can depend upon them to do their job well.

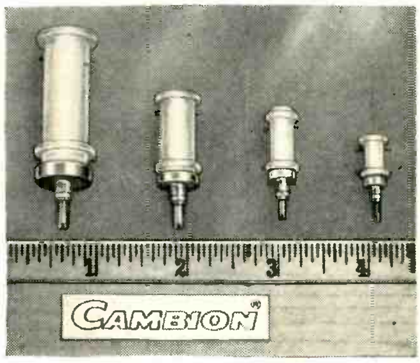
This built-in dependability is a result of Cambion's unique design plus quality control — that meets or betters government specifications.

Perma-Torq is a compression spring of heat treated beryllium copper, that has a very high resistance to fatigue and keeps coils tuned as set — even under extreme vibration and shock. The device also allows for immediate readjustment — without removal or loosening of any mounting nut or locking spring.

Quality control and features like the above are just two of the reasons why Cambion can offer you guaranteed standard or custom electronic components — whose performance you can rely upon.

Cambion researchers and practical experts are always available to help you solve your component problems. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 1560 Laurel St., San Carlos, Calif.

Cambion's new printed circuit coil forms are ideal for high temperature work and horizontal mounted panels. Equipped with Perma-Torq locking device for set tuning, the tuning core is affixed to the form at one end through a brass housing, thus eliminating internally threaded forms and cores and resulting in a more precise element with finer tuning. The coils, 2550, 2540, 2530 and 2525, are ceramic units with silicone fiberglas collars which have terminals for mounting on printed circuit boards.



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- **Collector Saturation Voltage of 0.1 Volt or Under**
- **Maximum Frequency of Oscillation in the 15 Megacycle Range**

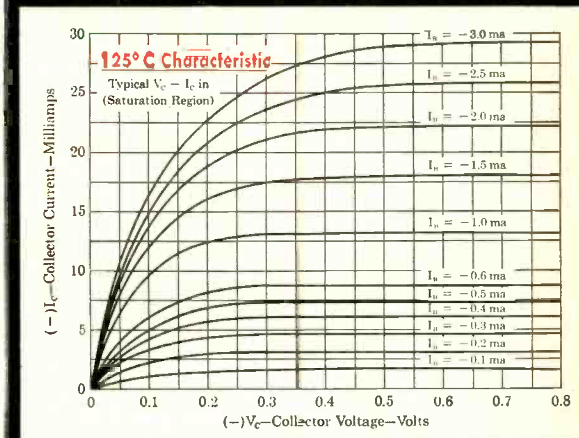
CHARACTERISTICS OF TYPES 2N495 and 2N496

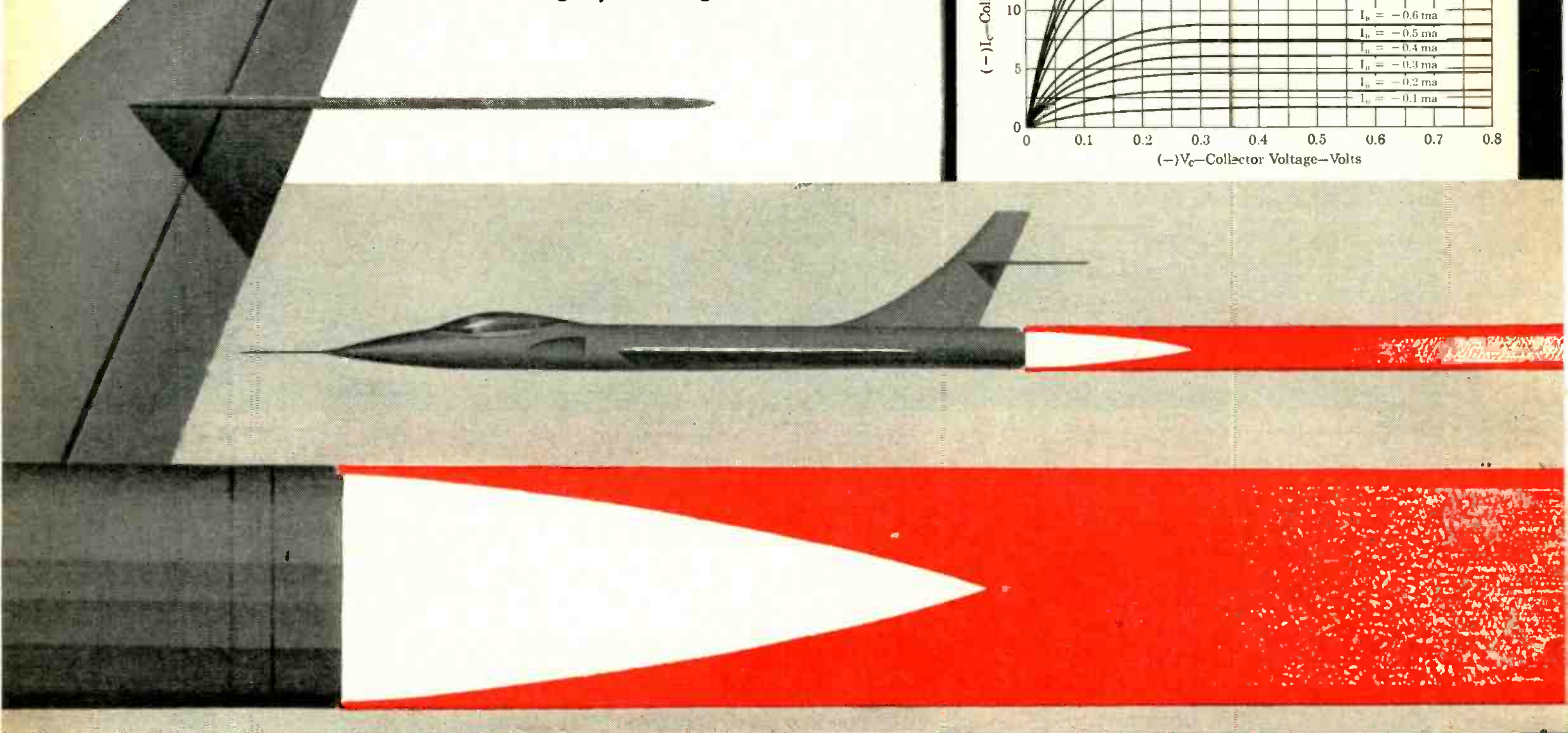
CHARACTERISTIC	CONDITION	TYPICAL VALUE 2N495	TYPICAL VALUE 2N496
Current Amplification Factor, h_{fe}	$V_{CE} = -6$ v $I_E = 1$ ma	18	
Current Amplification Factor, h_{FE}	$V_{CE} = -0.5$ v $I_C = -15$ ma		12
Output Capacitance, C_{ob}	$V_{CB} = -6$ v $I_E = 1$ ma	7 $\mu\mu$f	7 $\mu\mu$f
Maximum Frequency of Oscillation, f_{os} max.	$V_{CE} = -6$ v $I_E = 1$ ma	15 mc	
Frequency for Beta = 1, f_t*	$V_{CE} = -6$ v $I_E = 1$ ma f = 4 mc		15 mc
Cutoff Current, I_{CBO} or I_{EBO}	V_{CB} or $V_{EB} = -10$ v	.001 μa	.001 μa

Maximum Power Dissipation—150 mw

Maximum Collector Voltage 2N495—25 V
2N496—10 V

*f_t (the frequency at which beta is unity) is typically 85% of the alpha cutoff frequency.

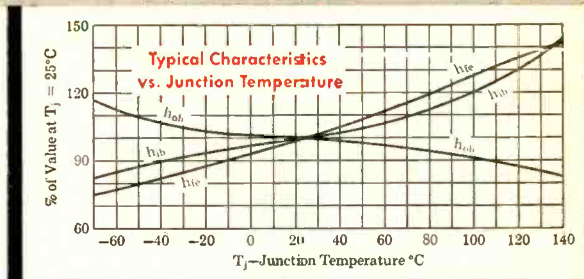




These new Philco PNP Surface Alloy Silicon Transistors permit transistorization of circuits where high ambient temperatures are encountered.

Type 2N495 is a general purpose silicon transistor, with excellent performance and reliability in amplifier and oscillator applications at frequencies through 15 mc. Units are rated at 150 mw total dissipation with a collector voltage rating of 25v.

Type 2N496 is specifically designed for high speed switching circuits . . . $f_{\alpha b}$ typically over 17 mc. This unit gives the designer the advantages of low saturation, low voltage operation and minimum load impedance even at junction temperatures as high as 140° C.



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electronics
engineering edition

FEBRUARY 28, 1958

Magnetic Resonance Determines Moisture

The absorption of radio-frequency energy by the nucleus of a hydrogen atom placed in a constant magnetic field is the principle used to measure the moisture content in hygroscopic solids. Nondestructive analysis of raw materials and end products can be conducted by nontechnical personnel, is accurate within 0.2 percent and may take as little as 30 seconds to make

By THOMAS F. CONWAY and ROBERT J. SMITH Corn Products Refining Co., Chicago, Ill.

RADIO-FREQUENCY SPECTROSCOPY, which covers the electromagnetic spectrum between the audio-frequency range and the infrared, is one of the physical methods now used by the chemist for qualitative and quantitative analysis of materials.

There are three well-defined branches of r-f spectroscopy: electron paramagnetic resonance, microwave, and nuclear magnetic resonance. The last method, based on the absorption of r-f energy by the nucleus of an atom placed in a constant magnetic field, is used to measure the moisture content of hygroscopic solids.

Application of this principle answers long-sought industrial need for a quick, accurate and nondestructive method of obtaining moisture-content control of raw materials and finished products.

Since nuclear magnetic resonance can be adjusted to detect atoms of some one hundred different isotopes many of which are used in various industries, it becomes apparent that its use as a method of moisture determination is only scratching the surface of its potentialities.

The measurement of sorbed water by nuclear magnetic resonance is based on the absorption of r-f energy by the nucleus of the hydrogen atom (proton).

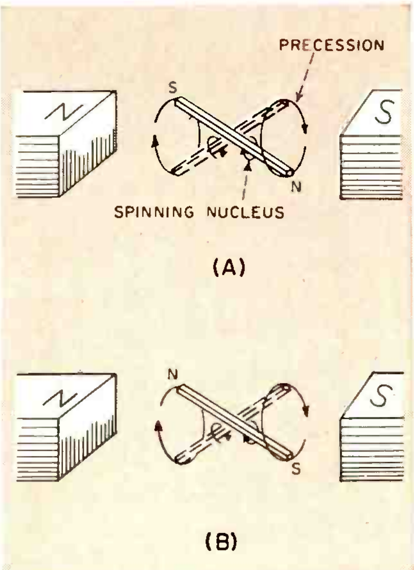
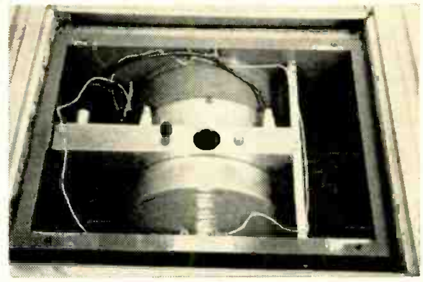


FIG. 1—Spinning nuclei of atoms wobble or precess in one of two positions: aligned with (A) and opposed to (B) the magnetic field. Nuclear magnetic resonance is based on nuclei behavior when exposed to an r-f field at right angles to the original magnetic field

In their natural state, hydrogen nuclei can be considered to resemble rapidly spinning tops with permanent bar magnets embedded along their axes of rotation. In the absence of external magnetic forces, these axes are orientated at random. However, when a constant magnetic force is exerted, the nuclei tend to align themselves in one of two positions: with or parallel to the magnetic field as in Fig. 1A and opposed or antiparallel to the magnetic field as in Fig. 1B.

Instead of lining up exactly with or opposed to the field, however, the axes of the spinning hydrogen nuclei wobble, or precess tracing cones in space as shown in Fig. 1. The frequency of precession depends on the inertial and magnetic properties of the nuclei and is proportional to the force of the external constant magnetic field.

When the precessing nuclei are exposed to a r-f magnetic field at right angles to the original magnetic field and the radio frequency is identical with the precession fre-



Top view of the magnet unit with cover removed shows cavity for sample bottle between the sweep-coil field

Operator obtains chart recordings of samples of varying moisture content. Sample jars are placed in the magnet unit at the extreme right of console

quency, a portion of the nuclei change from the parallel to the antiparallel position. This change absorbs energy from the r-f field. The amount of energy absorbed is proportional to the number of hydrogen nuclei and can be used as a measure of sorbed water.

The absorption of radio-frequency energy occurs only over a narrow band of frequencies centered around that of the resonance frequency.

Resonance Frequency

Resonance can be determined by holding the magnetic field fixed and varying the radio frequency or by holding the radio frequency steady and varying the strength of the magnetic field. The resonance analyzer uses the latter technique.

Precession frequency can be expressed as: $f = H_0 2\mu/h$ where f is the frequency at which the nuclei, or protons, precess; H_0 is the applied magnetic field strength; μ is the magnetic moment of the proton; and h is Planck's constant.

The analyzer, tuned to hydrogen resonance, detects hydrogen in any state of molecular combination. The precession frequency for the hydrogen nuclei is about 7.4 mc and H_0 is 1,750 gauss.

The nuclear magnetic resonance analyzer consists of two units: the magnet unit, into which the sample is inserted, and the console, with the controls and recorder.

Figure 2 is a simplified block diagram of the analyzer. The permanent magnet assembly is the core of the equipment. The sample tube, a Kimble cold-test jar containing a preweighed sample of the material to be tested, is inserted into the highly-homogeneous field of the permanent magnet. The jar is surrounded by a coil to which a fixed-frequency current is applied by an r-f oscillator. The coil is part of a sharply tuned parallel-resonant circuit.

When the total magnetic field applied is varied by adjusting a small current through the sweep coils wound on the poles, there will be a particular field strength which satisfies the precession frequency equation given above and there will be absorption of the r-f energy by the nuclei in the sample, as they change from the parallel to the antiparallel position. This energy absorption is amplified, detected and recorded.

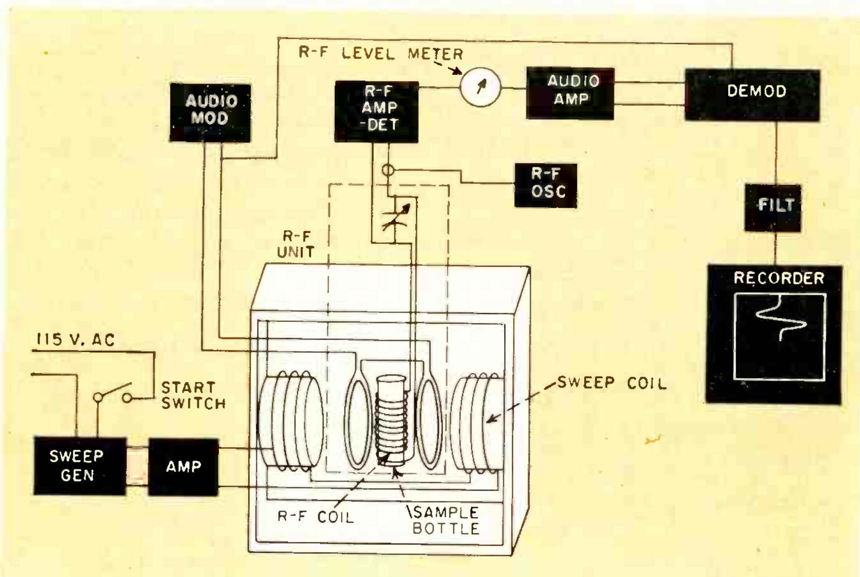


FIG. 2—Block diagram of the nuclear magnetic resonance analyzer. The bottle, containing a preweighed sample of the material to be analyzed for moisture content, is placed within the highly homogeneous field of the permanent magnet. The magnetic field is varied by adjusting a small current through the sweep coils wound on the poles of the permanent magnets. Instrumentation records the absorption of r-f energy by the nuclei of the hydrogen atoms in the sample

Absorption Line

If the absorption is plotted against the field H_o, an absorption line, the nuclear magnetic resonance spectrum, will appear as shown in Fig. 3A. The total area under the absorption line is proportional to the quantity of hydrogen present in the form of sorbed water (water line) and in the solid (solid line). The derivative of the absorption line, Fig. 3B, is recorded for a better interpretation of the spectra.

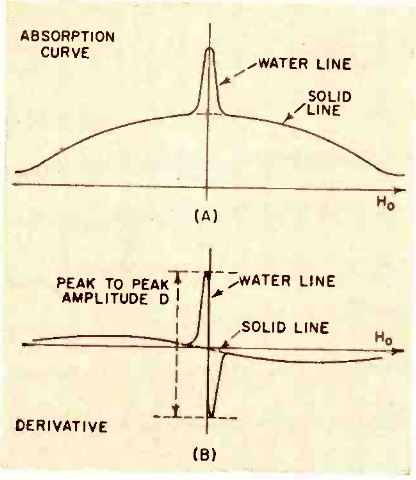


FIG. 3—Typical absorption line (A), and its derivative (B) for hydrogen-containing solids showing the total nuclear magnetic absorption as a result of the hydrogen nuclei in the solids (solid line) and in the form of absorbed water (water line). The analyzer records the derivative of the absorption curve

Disparity between the line widths of the hydrogen in a sorbed state and hydrogen in combination with the solid make it possible to obtain an accurate measure of the moisture content of hydrogen-containing solids.

The derivative curve is obtained by application of a square-wave current to the pair of modulating coils in the r-f unit. The magnetic field at the sample is modulated at a frequency of 33.1 cps.

Output of the r-f amplifier and detector consists of a d-c component which is the average value of the rectified r-f voltage across the r-f coil, plus an a-c component at the modulation frequency.

The a-c component is amplified then demodulated in phase with the modulating voltage. The demodulation output is filtered and recorded as the nmr derivative curve.

Feedback circuits make the output totally independent of the amount of r-f energy applied to the r-f coil, over a certain range, and increase stability of the reading.

Adjustment of the r-f level, sweep span, sweep time, modulation amplitude, signal range and filter-time constant are provided by selector switches. The wide range of precisely repeatable parameters gives the operator complete control over data presentation.

Hydrogen Mobility

Despite the fact that the magnetic field strength at the center of the hydrogen-resonance line always has the same value for a given frequency, the shape of the line is influenced considerably by the chemical and physical state of the hydrogen in the sample.

Absorption line width is related to the hydrogen mobility in the sample and the homogeneity of the magnetic field over the volume of the sample.

An especially designed permanent magnet with 10-in. pole faces allows optimum sample volumes to be analyzed and diminishes inhomogeneity of the magnetic field.

Nuclear magnetic resonance depends on the total effective magnetic field strength at the individual nucleus and the total field is the sum of the applied magnetic field at that point plus fields contributed by proximate magnetic particles such as spinning magnetic nuclei.

In a liquid, the molecules are in a violent state of thermal agitation and the fields contributed by hydrogen nuclei at any given point are averaged out rapidly compared with the period of precession. As a result, the nuclear magnetic resonance absorption line is narrow. In pure mobile liquids, such as water, the line width will be determined basically by the inhomogeneity of the applied magnetic field. In the analyzer, departure from the field homogeneity over the volume of the sample is only a few milligauss.

In a solid, the hydrogen, nuclei are fixed rigidly in place with respect to the adjacent and proximate nuclei and are capable of only restricted motion. Because of the fixed spatial orientation of the neighboring nuclei, a given nucleus will find itself in a total magnetic field significantly lower or higher than the applied field. Since the nuclei will pass through magnetic resonance at widely varied values of the applied magnetic field, the line width will be comparatively broad, of the order of several gauss.

The analyzer records the derivation of the absorptive line in the region of the narrow water absorption and the contribution due to the solid is negligible, see Fig. 3B.

By comparison of the peak-to-peak height D of the derivative curve on a number of materials of varying moisture content, with moisture as determined by standard laboratory methods, highly satisfactory correlations can be established for any material, see Fig. 4.

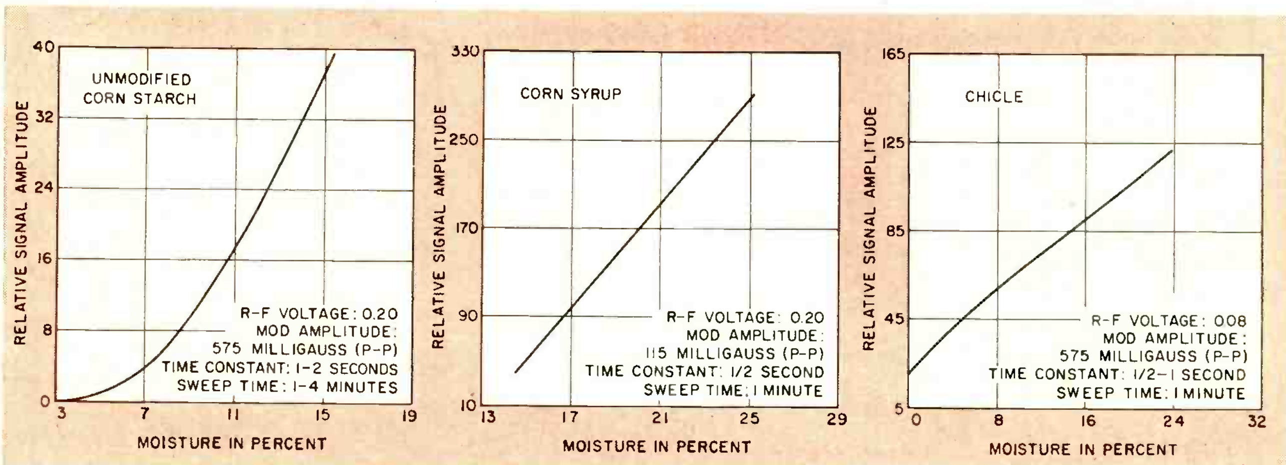


FIG. 4—Nuclear magnetic resonance signal amplitude is plotted against moisture content for unmodified corn starch (A), corn syrup (B) and chicle (C). When testing the same type of material no machine adjustments are required

Pulse-Cross Modification

Phantastron circuits delay horizontal and vertical sync pulses when added to monitor or tv receiver to provide pulse-cross display. System gives simple means of checking operation of station sync generator

By HAROLD E. O'KELLEY*

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TELEVISION sync generators usually provide an output during the vertical blanking interval consisting of six equalizing, six vertical, then six more equalizing pulses. Since this group of pulses occurs only once every field and has a repetition rate of 31,000 pps, it is difficult to obtain an oscilloscope display which is readily seen. A convenient way of displaying these pulses is the pulse-cross method.

If the vertical synchronizing pulses are delayed for 1/120 second, the vertical blanking signal will appear as a dark horizontal line vertically in the center of the picture. Delaying the horizontal synchronizing pulses 1/31,000 second will cause a dark vertical bar, centered horizontally, to appear. With brightness and contrast controls adjusted properly, the blanking pulses appear as gray and the synchronizing pulses as black.

A pulse-cross display is detailed in Fig. 1. Since the pulse repetition rate of the equalizing and vertical synchronizing pulses is twice that of the horizontal synchronizing pulses, two equalizing and vertical pulses appear in one horizontal scan. The simplest method for obtaining the necessary pulse time delay is to form a new pulse from a triggered or synchronized oscillator. For example, Fig. 2A shows a synchronizing voltage waveform obtained from a television receiver. This waveform can be used to trigger a monostable multivibrator so that, at one tube plate, the waveform shown at Figure 2B is obtained. The positive-going voltage is then used to synchronize the scanning oscillator in the television receiver and the resulting time delay is as indicated. Since different values of time delay are required for vertical and horizontal scans, two separate delay circuits are used.

Cathode-coupled phantastrons are used as monostable relaxation oscillators in the pulse-cross device of Fig. 3. Pentodes V_2 and V_3 are cathode-coupled phantastrons. Tube V_2 delays the horizontal sync pulse while V_3 delays the vertical sync pulse.

Circuit Operation

In the stable state divider network, R_4 and R_5, establishes the suppressor grid at a potential which prevents plate-current flow. Hence all cathode current is flowing to the screen and control grids. The control-grid potential is practically that of the cathode.

If a positive pulse is applied to the suppressor grid, plate current will flow. This results in a decrease in plate voltage which is coupled to the control grid through C_3 reducing the cathode and screen-grid currents. After the initial voltage step down at the plate, the plate voltage runs down almost linearly because of the Miller integration action of C_3. At the end of rundown, provided the trigger voltage at the suppressor is removed, the tube returns to the stable state.

During the quasi-stable state the cathode and screen-grid currents are decreased. Consequently, a negative-going pulse is produced across the cathode resistor R_9, and a positive-going pulse is produced at the screen grid. The positive-going trailing edge of the pulse at the cathode of V_3 is used as the vertical sync pulse.

Diode D_1 and potentiometer R_6 establish the plate voltage during

* Now with Radiation, Inc.

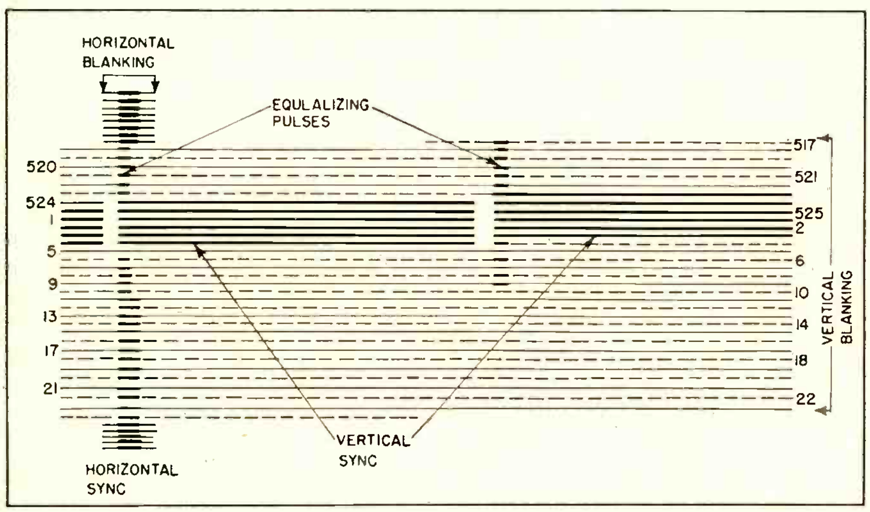


FIG. 1—Enlarged pulse-cross section on tv screen with dashed and solid lines indicating alternate fields. Two equalizing and vertical pulses appear in one horizontal scan

# of Tv Receivers

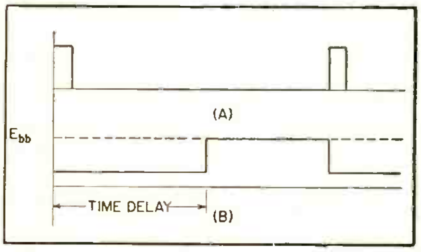
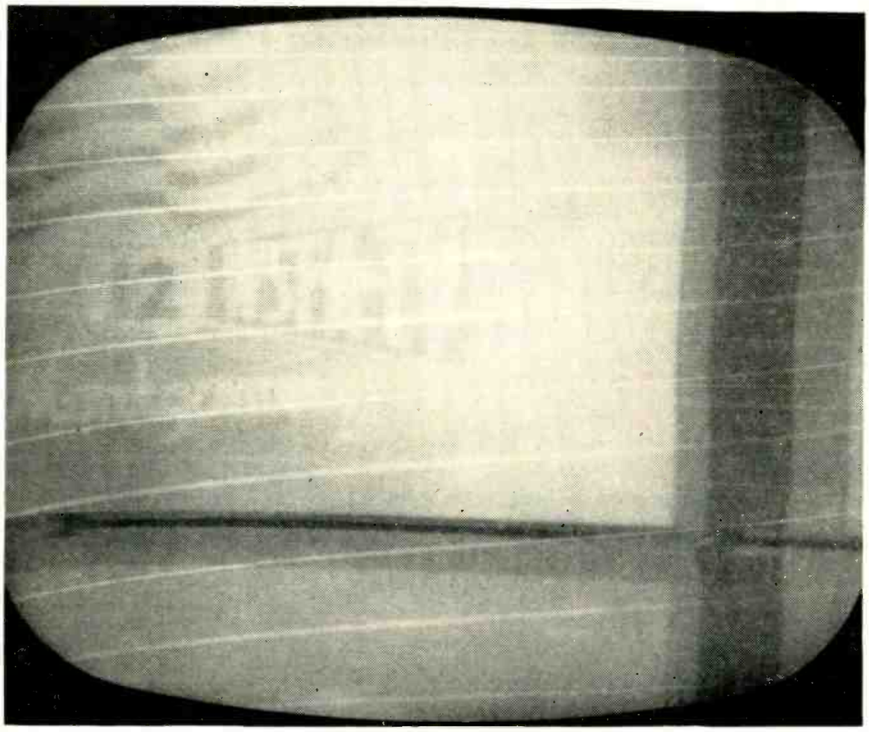


FIG. 2—Trigger voltage from sync clipper in tv receiver (A) and output waveform at plate of monostable multivibrator (B)



Pulse-cross display obtained by phantastron delay circuits in tv monitor

the stable state. The lower the initial plate voltage, the less the rundown time or time delay provided.

Some care must be used in selecting resistances R_4, R_5 and R_{18} R_{19} because these networks establish the bias voltages for the suppressors which should be slightly beyond cutoff so noise and spurious pulses do not initiate plate rundown.

Triode V_{1A} is used for pulse amplification and the input sync signal must be negative going. Network C_2 R_4 R_5 differentiates the pulses for application to the phantastron suppressor grid. An output pulse is taken from the screen grid and differentiated by R_{11}, C_4 and R_{12}. Diode D_2 clips the positive-going pulse so that only a negative-going pulse is applied to the grid of V_{1B}, a paraphase amplifier.

Delayed sync pulses appear at the plate and cathode of V_{1B}. At the plate, the pulses are positive going and at the cathode the pulses are negative going.

If a horizontal-frequency discriminator is used in the receiver, the required balanced and delayed pulses are available at the plate and cathode of V_{1B}. If a single-ended positive pulse is required, it is available at the plate of V_{1B}.

Network R_{16}, R_{17}, C_6 and C_7 integrates the pulse train so that vertical trigger pulses for V_3 are formed. The vertical delayed sync pulse is available at the cathode of V_3. Potentiometer R_{20} is the vertical time delay control.

With receivers which have keyed agc, this circuit must be disabled. This is necessary because the keying signal is obtained from the horizontal output stage. When a pulse-cross display is given, instead of developing an agc voltage dependent upon the magnitude of the sync signal, the agc voltage is dependent upon the illumination of some point in the picture. To overcome this difficulty, the keyed agc tube is removed and a negative voltage connected to the agc bus. This can be obtained by rectifying the output from two series 6.3 volt transformer windings providing an output voltage of 0 to -15 volts.

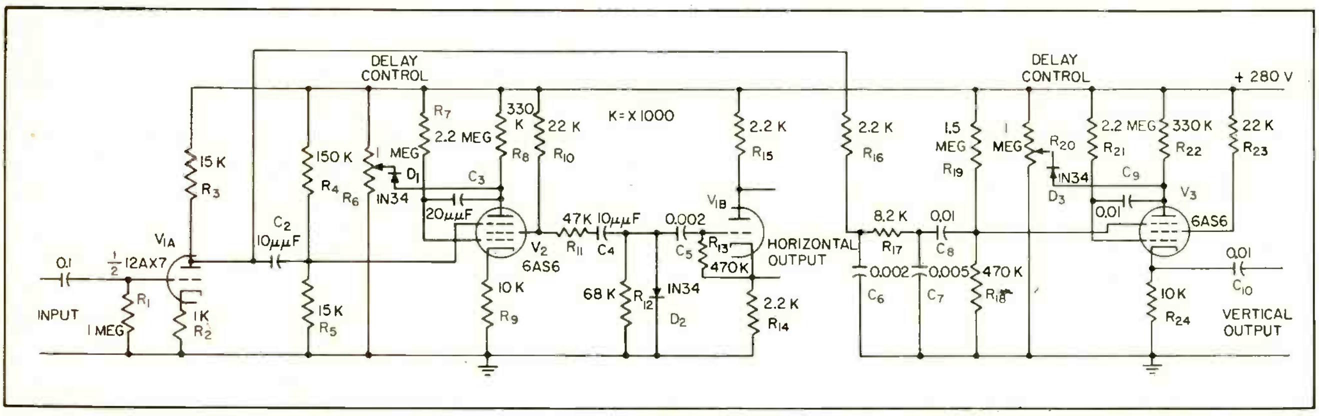


FIG. 3—Phantastron circuits delay sync pulses for horizontal and vertical sweeps

Requirements for the satellite electronics systems are much the same as for any equivalent aircraft or rocket system, but are greatly magnified in importance. Weight reduction is mandatory. Operating power must be held to an irreducible minimum. And, since many unknowns exist, equipment must be operable over a wide range of ambient conditions. This discussion of satellite electronics is not intended to be a complete discourse on the topic. It serves, rather, as an introduction to the so-called Lyman-alpha environmental satellite of Vanguard with emphasis on the telemeter encoder, memory and meteor counter.

Cyclops Cores Simplify

Part I
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Part II
By R. W. ROCHELLE, Head, Magnetic Amplifier Section, Solid State Division, N.R.L., Wash., D. C.

Part III
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Part I—An Introduction to Scientific Satellites

SATELLITE STRUCTURES will, in general, consist of hollow magnesium-alloy spheres 20 in. in diam with total weight limited to 21.5 lb. About 10 lb is devoted to the shell, internal structures and mechanism for separation of the satellite from the burned out third-stage rocket.

All electronic equipment and associated batteries are installed in the centrally located, pressurized instrumentation compartment, except for instruments and antennas which must be attached to the outer shell. The front cover of this issue shows encapsulated circuitry being inserted in the 5.5-in. diam, 7-5-in. high instrumentation compartment.

Other Instrumented Satellites

Instrumented satellites will be of several types, each containing a different combination of scientific experiments. In addition to the Lyman-alpha satellite discussed in the remaining sections of this article, additional types are being prepared.

A second satellite design will incorporate two experiments. In one, an airborne proton resonance magnetometer will study the earth's magnetic field at high altitudes. Signals will be transmitted only on interrogation.

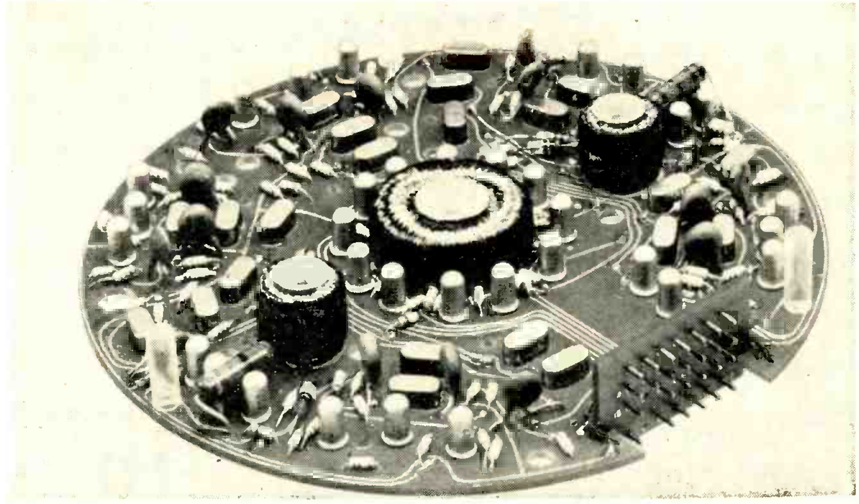
In the other experiment, air-density measurements will be made by determining the drag on an inflatable sphere. These measurements will be similar to those made by the satellite themselves but will be made faster because of the greatly enhanced drag-to-mass ratio.

A third satellite type will be directed toward a study of radiation balance in space. Four small spheres will be located at the antenna tips. Spheres of differing absorptivities and emissivity will be used, with and without radiation shields. A study of their individual temperatures can reveal much valuable information. Signals will be recorded on tape and transmitted only on interrogation.

A fourth scientific satellite is devoted to a study of the earth's albedo for meteorological purposes. As the satellite spins, photosensitive devices will scan the earth's surface. Detail will not be great, but general distinction will be made between land masses, water and cloud cover for correlation with weather phenomena. Again, information will be recorded for playback only upon interrogation.

All telemetered scientific data will be transmitted by amplitude

* Now with Magnetics, Inc., Butler, Pa.



Encoder portion of Lyman-alpha satellite. Memory and counter are similar in appearance. Each unit is encapsulated and is about ¾-in. high. Unit modules are assembled on two rods to form a single package

Earth-Satellite Circuits

modulation of the Minitrack radio tracking transmitter operating at 108 mc. Tracking data is obtained by phase measurements at 500 cps. Tracking accuracy demands that any modulation signal during the tracking interval contain no signal components in the range from 500 to 2,500 cps. Signals transmitted only on interrogation can use this band by waiting until tracking data has been obtained.

Spectrum Utilization

To reduce noise by narrowing the passband of the receiver, the signal should contain maximum information in the narrowest possible bandwidth. Maximum signal frequency components have been set at 15 kc for this reason.

Part II—Satellite Telemetry Coding System

SEVENTEEN TRANSDUCERS located on the shell and in the internal package of the Lyman-alpha earth satellite measure such parameters as temperature, collision with micrometeorites and solar Lyman-alpha radiation. Signal inputs from each of these transducers must be encoded for modulation of the Minitrack transmitter. Figure 1 is a block diagram of the complete satellite.

By using transistors and magnetic cores in a system combining both f-m and time-sharing modulation, weight of the encoder was reduced to 3.8 oz and the batteries to 2.8 oz. Expected life was over a month of continuous operation. The resulting system has a capacity of 48 channels of telemetered information.

Outputs from the satellite transducers are in the form of variable resistances or, as in the case of the Lyman-alpha test, in the form of currents or voltages. The encoder takes these currents or voltages and makes the frequencies of tone bursts proportional to them. The on time of the burst and the time between bursts is proportional to the resistive values of the transducers. Three channels are represented by each tone burst.

The modulator output is a series of tone bursts in the frequency range from 5 to 15 kc.

Timing Multivibrator

Gates, which determine the lengths of the tone bursts, are generated by a timing multivibrator and a transistor matrix. In its simplest form, the timing multivibrator is as shown in Fig. 2. Two transistors, a square-hysteresis-loop magnetic core, and two transducers (R_1 and R_2) are used to produce a square-wave output.

Transistor Q_1 drives the magnetic core towards positive saturation. Transistor Q_2 takes it to negative saturation by regenerative action of the base winding.

Transducers R_1 and R_2, which

ABOUT LYMAN-ALPHA RADIATION

Solar radiation always contains energy in the Lyman-alpha region. Since the earth's atmosphere is quite opaque in this radiation, high-altitude rocket or satellite techniques are mandatory to obtain data. Marked increases in radiation are anticipated during solar flares. Random and infrequent occurrence of the flares, short life of research rockets, and time required for rockets to be placed in position for these measurements, present formidable obstacles to the gathering of data pertaining to this radiation.

A satellite under continuous observation would be an almost ideal vehicle for study of this phenomenon. Since continuous observation is impractical, compromises may be made which permit collection of valuable information. Background radiation from a quiescent sun may be studied by measurement of instantaneous values of this radiation as the satellite passes over the data collection stations. Correlation between visually observed solar flares and Lyman-alpha radiation may be obtained by storing and transmitting information regarding the maximum value attained during each orbit might be thermistors or pressure gages, drop the battery voltage across the core. This action is accomplished by the magnetizing current flowing through R_1 and R_2 during each half cycle. Flux in the core at any time is the time integral of the voltage across the core. Reduced core voltage increases the time needed before saturation of the core is reached.

Variations in transducer R_1 will cause the length of the positive half-cycles in the output to vary independently of the negative half-cycles. Similarly, variations in R_2 will change the length of the negative half-cycles, independently. As actually applied, the half-cycle lengths can be varied over a dynamic range of 5 to 30 millisec for transducer resistance changes from 0 to 5,000 ohms. Only the positive half-cycle is used to gate on a higher frequency square-wave magnetic-core multivibrator. This multivibrator is termed a tone-burst oscillator.

A system containing only a timing multivibrator which gates on one tone-burst oscillator would be capable of telemetering three channels. These channels would be for frequency of tone bursts, length of the tone burst and time duration between tone bursts.

Extension of the system to more than three channels is accomplished as shown in Fig. 2. As many as six or eight base windings may be added to the magnetic core of the timing multivibrator. Each centertap to the base winding is brought out externally and biased so that none of the transistors are turned on. If a negative voltage or gate is applied to centertap A, transistors Q_1 and Q_2 will conduct alternately. Transducers R_1 and R_2 will determine length of the positive and negative half-cycles in the output, respectively. If centertap B is energized with a gate after removing the gate from A, R_3 and R_4 will control the lengths of the positive and negative half-cycles. Any of the pairs of transducers may be switched in alternately by applying a gate at the proper centertap.

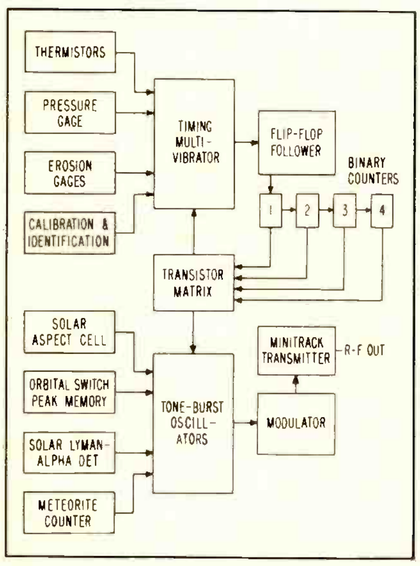


FIG. 1—Block diagram of the complete Lyman-alpha earth satellite

Transistor Matrix

The transistor matrix in the encoder supplies the sequential gates. The matrix switch gates at the end of every full cycle of the timing multivibrator so that each transducer controls the length of a half-cycle in sequence.

A flip-flop follower, Fig. 3, and four tandem binary-counters count down the cycles of the timing multivibrator. The transistor matrix samples the states of the binary stages and produces a unique gate for each combination of binary states. There are 2^N states so that with four binary stages there are 16 unique states. Each gate turns on its own pair of transistors through the centertapped base winding.

The flip-flop follower removes any loading from the timing multivibrator. Output of the follower is used in an AND circuit with the matrix gates to turn on the tone-burst oscillators or multivibrators during the positive half-cycles only. A wider bandwidth is needed for the instantaneous Lyman-alpha channel and the solar cell in the satellite because readings will be modulated by the satellite roll rate. By paralleling matrix output gates, a group of channels is repeated six times each frame to provide more telemetry time. This arrangement increases the channel bandwidth effectively. Normally, four binary stages with 16 base windings on the timing multivibrator core will produce 48 separate channels of information. By paralleling matrix

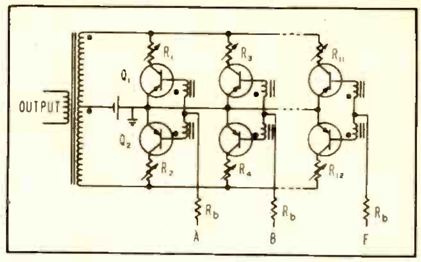


FIG. 2—Timing multivibrator for 49-channel telemetry system

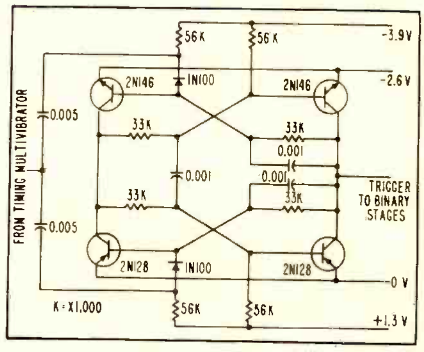


FIG. 3—Circuit diagram of the flip-flop follower used to count down

output and using only six base windings, Fig. 4, some channels are repeated several times during the 48-channel frame.

Binary stages, Fig. 5, are unique in that a steering-circuit transistor replaces the two back-to-back diodes used normally. Current gain of this transistor is utilized in triggering. It drives the bases of the binary transistors through capacitive coupling and is decoupled from the low saturation impedance of the on transistor by the 3,900-ohm resistor.

Half the time, the steering transistor is used in the inverted-alpha condition, since the binary carries the emitter more negative than the collector. Many surface-barrier transistors have betas in the inverted-alpha connection almost as large as in the regular connection. The four-transistor flip-flop or binary connection reduces total quiescent drain on the batteries.

The tone-burst oscillators, gated on by the matrix, may be of several different types. The instantaneous Lyman-alpha and solar aspect cell drive one type, which is a variable-frequency magnetically coupled multivibrator. Two magnetic cores, Fig. 6, are battery-driven by the two transistors. Base windings are regenerative. When one core is driven towards satura-

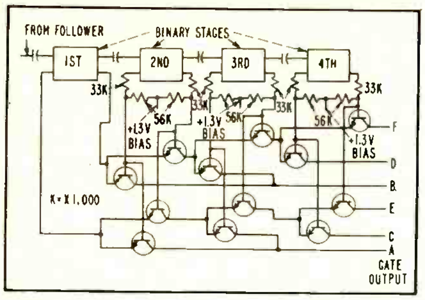


FIG. 4—Binary stages and transistor matrix. All transistor types are 2N146

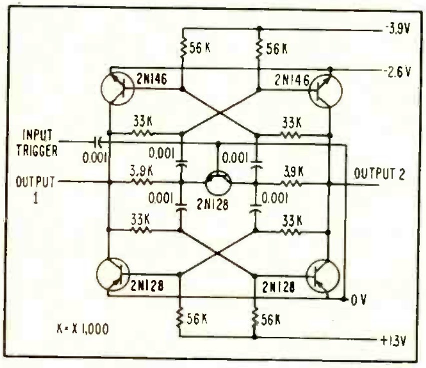


FIG. 5—Schematic diagram of a binary stage. Four are used in system

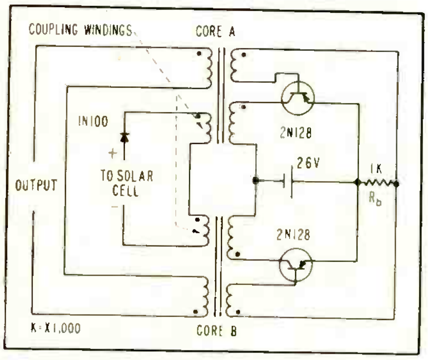


FIG. 6—Variable-frequency magnetically coupled tone-burst oscillator

tion by its transistor, the second core is reset through a coupling winding. At saturation, the circuit switches and the second core begins resetting the first. Injection of a current or voltage in the coupling circuit causes a change in the reset. This change varies the multivibrator or tone-burst-oscillator frequency. Variation from 30 to 700 μa can change the frequency from 5 to 15 kc. With a slight change in the coupling winding circuitry, 0.5 v from a solar cell will cause the same frequency shift.

Another type of tone-burst oscillator, termed a Cyclops will be described in Part III of this article, dealing with the analog magnetic memory of the satellite. There are three Cyclops oscillators in the meteoritic collision module and two in the peak reader. One operates every other orbit while the other stores information. The Cyclops oscillators plus the variable-frequency magnetically coupled multivibrator make a total of six tone-burst oscillators in the satellite. Each is turned on by the sum of the gates from the matrix and the follower.

Outputs of the tone-burst multivibrators are parallel-added to drive the modulation stage, Fig. 7. Multivibrator outputs are decoupled through diodes. Since only one multivibrator is gated on at a time, there is no interaction between multivibrators. Modulation transistors serve the dual purpose of amplifying and clipping. Clipping insures 100-percent modulation of the transmitter.

Synchronization

Because tone-burst lengths and spaces are functions of transducer values, the frame rate is variable. If the average resistance of the transducers is low, the frame rate will be fast. More information can be sent per unit time by this system than in conventional ones which allot a fixed time duration for each channel. Since the frame rate is not constant, the signal must be unique so that individual channels may be identified. By using a few fixed values of resistance in place of some transducers, a key is formed and calibration is provided.

Part III—Analog Magnetic Memory

STORAGE and readout requirements encountered in certain Lyman-alpha experiments demand special equipment. In this experiment, the Lyman-alpha line of hydrogen in the solar spectrum must be measured and correlated with optical observations of solar flares. One reason for the measurements—suspicion that variations in Lyman-alpha, due to solar flares, may be a contributory cause of radio fade-outs.

In the Lyman-alpha satellite, information transmission will be continuous. This operating method requires two storage elements. One stores peak intensity information during one orbit. The other transmits information gathered during the previous orbit. Since the storage element must transmit continuously the information it received previously, nondestructive readout must be used. In addition, functions of the storage elements must be switched automatically once each orbit as the satellite passes from darkness into sunlight.

The developed system accepts information in the form of d-c values from a few μa to one ma. It remembers the maximum current value that has been applied to it and retains this information until it is erased deliberately. This informa-

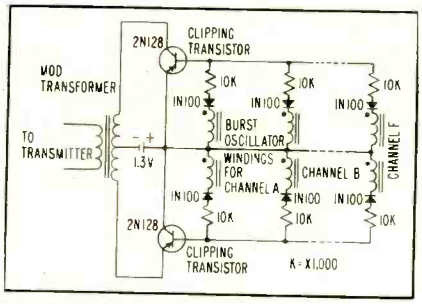


FIG. 7—Clipper and modulator stage

tion is presented directly in the form of alternating current with frequency a function of the stored information level.

Measurement is accomplished with a technique originated at the Naval Research Laboratory. Radiation impinges upon an ion chamber designed to respond only to the desired spectral line. The resulting minute current is amplified by an electrometer and fed to the memory unit. Information stored in the form of flux level in a square-hysteresis-loop magnetic material will remain until removed by external means. This method for storing the peak Lyman-alpha information is used.

The magnetic core must assume a certain flux level for a given value of current flow. The core must remain unaffected by any subsequent currents unless they are larger than any previous currents. In such a case, the core must assume a new flux level. In other words, the core must not integrate in the steady state.

Once the method of storing the information was established, the next problem was to translate the information into a usable form. To make the system compatible with the requirements of the encoding system, generation of an alternating voltage waveform with frequency proportional to information was necessary. It was felt desirable to obtain the readout with a single magnetic core and appropriate circuits.

During this experimentation, a two-aperture memory core named the Cyclops, Fig. 8, was suggested. It could be fabricated by drilling a hole through one wall of a tape-wound core. Outer convolutions of a tape-wound core shield the inner convolutions. As a result, the device is insensitive to stray fields.

When a signal is applied to the input windings, Fig. 8, a stored flux ϕ is established in the main core as a function of the applied signal. Flux ϕ divides at the hole along paths ϕ_A and ϕ_B linking the readout windings A and B. A current-limited magnetic multivbrator is connected to windings A and B. When the windings are excited alternately, there are flux changes in opposite directions around the small hole but in the same direction as ϕ in the main core.

Nondestructive Readout

Assume that flux ϕ has been set by a signal from the input winding. Assume, further, that flux ϕ saturates the iron on each side of the hole at ϕ_A and ϕ_B in the direction indicated in Fig. 8. The input signal is removed and the multivibrator is turned on. Because of the difference in B_r and B_{max}, a small clockwise flux change about the hole will be caused by current in winding A when the upper transistor gates. A similar small flux change in a counterclockwise direction will be produced in winding B when the lower transistor gates. Since, in this case, the amount of flux changed can only be small and the time each transistor is switched on is short, the multivibrator operates at a high frequency.

Next, assume that a reverse current is passed through the input windings on the main core so that flux level ϕ is reduced to zero and the main core is demagnetized. When the multivibrator is energized, there will be a large amount of flux reversed each half-cycle. This results in a low operating frequency for the multivibrator. For intermediate levels of ϕ, there will be corresponding intermediate frequences.

Memory-Core Circuitry

Use of two Cyclops memory cores to record peak current from the Lyman-alpha detector leads to other requirements. A means is needed for wiping out the memory and resetting one core. A commutative switch is necessary to connect the other core containing stored information to the telemetry encoder.

In Fig. 9, the left side of the curve is used to store current information from the electrometer tube. It is best suited to store currents in the required range of 20 to 700 μa. Reset must be provided to restore the core saturation each time the memory is erased. For precise measurement, it is unsatisfactory to simply reverse current in the winding. It is also poor practice to apply a single reverse voltage pulse and attempt to return to the exact frequency each time.

To maintain high accuracy, a resetting circuit was devised consisting of one negative and one positive pulse. First, the negative pulse drives the core to negative saturation in the same direction that negative control current would normally set the core. Next, the positive pulse restores the core to positive saturation or to the point of origin at a high frequency. By this technique, repeated resets with or without previous input currents restores the frequency to within one percent of its original value.

Figure 10 includes the transistorized resetting circuit used with the peak memory cores. The circuit as shown is for two cores. One half is essentially a duplication of the other except for connections to the orbital switch and frequency range. One multivibrator has a frequency range from 4 to 8.5 kc; the other, 8.5 to 14 kc. The two different ranges permit core identification.

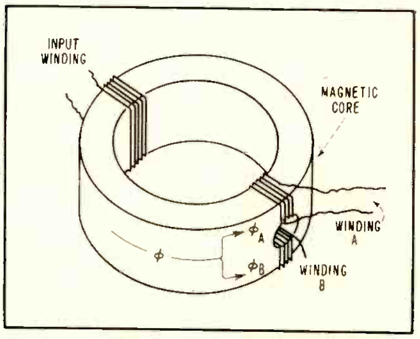


FIG. 8—Basic Cyclops core and winding configurations

A magnetic multivibrator is formed by windings L_3 and L_5 in the collector circuits of *pnp* transistors Q_1 and Q_3 and windings L_7 and L_9 in the base circuits of these same transistors. This multivibrator would be free-running if transistor Q_5 were short-circuited.

Basically, the multivibrator is a normally closed switch biased to conduction from the +1.3-v bus. When a pulse is delivered from the orbital switch via terminal C' and transistor Q_5, transistor Q_1 is momentarily switched on and L_3 is energized. A voltage induced in L_7 clamps Q_1 on until the core reaches negative saturation. Then, the inductive kick in L_9 switches Q_3 on. It is held on until the core reaches positive saturation. During this interval, the capacitor to the base of Q_5 is charged negatively and cuts off Q_5, disabling the circuit from sustained oscillations.

The single negative and positive pulses obtained with the circuit are satisfactory to obtain accurate reset of the core in about one millisec. Switches at A and A' are caused to lag C, C' to prevent current flow in the memory winding during the one-millisec reset interval.

Temperature characteristics of the resetting circuit were improved by use of thermistors in the bias circuits of the main switching transistors Q_1, Q_2, Q_3, and Q_4. At elevated temperatures, where I_{co} normally increases, thermistor resistance is lowered. This action increases the bias current from the +1.3-v bus which passes through the diodes in series with the base windings. The bases of the switching transistors are thus kept at a constant positive bias voltage.

Core Input and Readout

Windings L_1 and L_2 are the input or set windings on the main section of the cyclops cores.

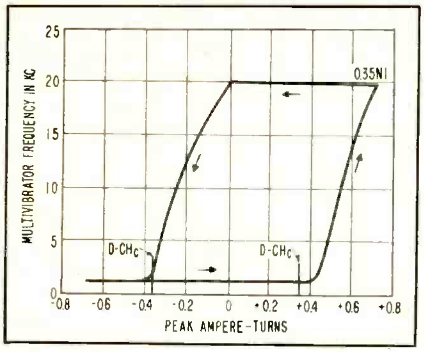


FIG. 9—Multivibrator frequency of a wound toroidal core as a function of current. Slope of the curve is influenced by the inner diam—outer diam ratio of the cores as well as the material

These windings carry the cathode current from the electrometer tube and are controlled by switches at *A* and *A′*.

Windings L_{11} and L_{12} are the multivibrator windings in the holes of the cores. Switch terminals labeled *B* and *B′*, Fig. 10, connect only one multivibrator for readout to the negative bus depending upon the state of the orbital switch. Connection to ground or the positive bus is made through a 2N128 transistor which is switched on and off at the command of the encoder.

When both positive and negative bus connections are made, the appropriate multivibrator is turned on. Next, either output winding L_{13} or L_{14} delivers a tone burst to the modulator of the Minitrack transmitter. A full-wave diode bridge couples the output windings of each Cyclops multivibrator to the modulator. This bridge provides the maximum available driving voltage to the bases of the push-pull class-B modulator transistors. Even with a temperature-stable resetting pulse on the core, there is an output frequency decrease with an increase in temperature caused by thermal effects on the core alone. These thermal effects are compensated by an inverse thermal characteristic of the multivibrator transistors. With use of the thermistors mentioned previously, plus the self-compensating circuit components, the complete circuit maintains ±5-percent accuracy over a temperature range from −50 to +70 C.

Orbital Commutation

Design of the commutator which interchanges the two memory cores once each orbit called for minimum power dissipation since the switch circuit would be in continuous operation. A rough approximation, taking into account the contemplated battery type, indicated 10 mv-amp drain would cost one oz of weight for two to four weeks of operation.

One channel of information presented to the encoder is the instantaneous aspect or angle of the satellite axis with respect to the sun. This information is gathered by a silicon-junction photocell mounted on the equator of the sphere. A regular $1\frac{3}{8}$-in. diam round solar cell was secured and a $\frac{3}{8}$-in. diam hole cut in the center. Back of this, three $\frac{1}{2}$ by $\frac{3}{32}$-in. strips of the silicon junction material were mounted and connected electrically in series to give a higher voltage for the orbital switch.

The orbital switch is designed to trip on the first increase in incident light level occurring after any five-minute absence of solar radiation. It then locks out against any recurrent variations which may occur at a rate of more than once per five-minute period. When the switch trips, it initiates a pulse. This pulse wipes out the memory of the element that has been transmitting information and connects it into the electrometer circuit prepared to read and store peak-intensity information. Simultaneously, the pulse connects the element which has been storing information into the readout circuit.

A circuit for obtaining these ac-

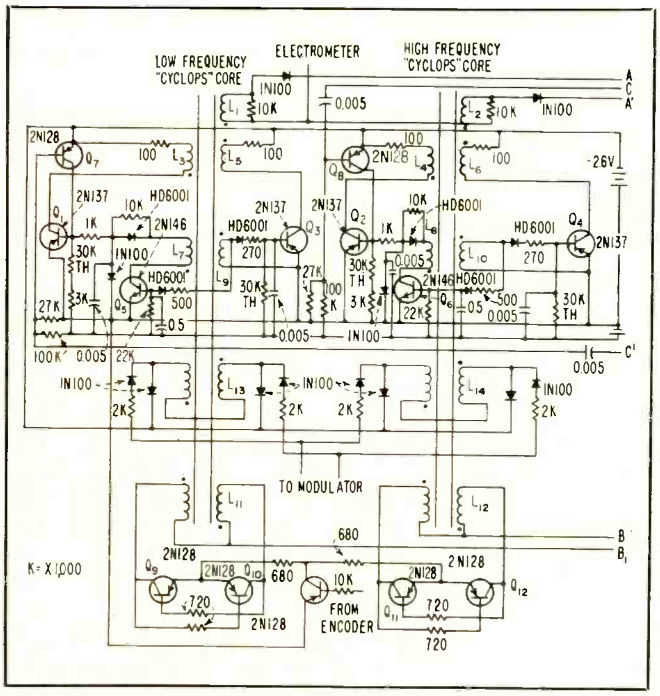


FIG. 10—Resetting circuitry used with the low- and high-frequency Cyclops memory cores

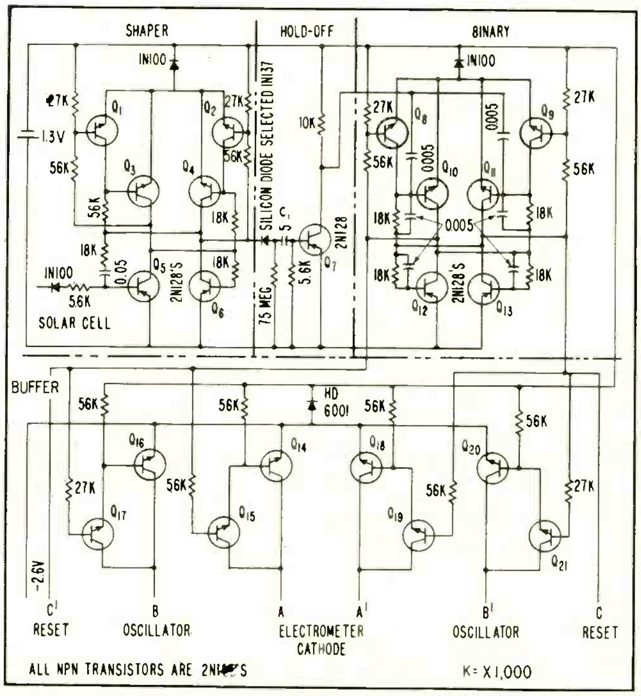


FIG. 11—Orbital switch circuit. Shaper is essentially a monostable multivibrator

tions is shown in Fig. 11. The multivibrator stages employ so-called complimentary multivibrator circuitry. Ordinary multivibrator flip-flop connections are used but *npn* and *pnp* transistors are connected in series and substituted for the load resistors. The common base voltage which turns one transistor off will turn the other on. Any load tied to the common collectors will be supplied through a low-impedance source when on but a high impedance is presented to the battery when off.

Shaper Circuit

Operation can be clarified by considering operation of the input shaper circuit. For the present, transistors Q_1 and Q_2 will be assumed open. Transistors Q_3, Q_4, Q_5, and Q_6 constitute the basic monostable multivibrator. In the normal state (no signal), input transistor Q_5 is off and Q_3, in series with Q_5, is saturated on. Corresponding transistors on the other side are in the opposite condition.

As the signal rises, increased current begins to flow through the series *npn* transistor Q_3. When this current becomes large enough so that Q_3 is no longer operating in the saturated region, a voltage appears across the emitter-collector terminals of Q_3. This voltage is transmitted to the d-c coupled transistors on the opposite side. Eventually, the voltage changes produce a regenerative state and the multivibrator rapidly flips. The multivibrator will stay in this position until a decrease in input causes it to resume its normal position.

Increased leakage currents in switching transistors at high temperatures can tend to upset circuit operation. One of the usual compensations is a series emitter resistor. In these circuits, a diode in series with the emitters is used instead of the resistor. The diode gives higher biasing voltages at small leakage currents and less voltage drop at high load currents.

The circuits can be kept operating at high temperatures by using low resistance values from base to bias voltage source to keep the off transistor off. But high resistance values are required at low temperatures to turn the on transistor on. Connection of transistors Q_1 and Q_2 across the base and emitter terminals of the multivibrator transistors Q_3 and Q_4 offsets these conflicting requirements.

Transistors Q_1 and Q_2 act as switches driven from the collectors of their respective multivibrator transistors. A low impedance connects the base and emitter of the multivibrator transistor when it is in the off position. When a multivibrator transistor is on, base-to-emitter resistance is high (open switch) to prevent bypassing of the base current. This compensation is required on the *npn* transistors only since the type of *pnp* transistor chosen is relatively insensitive to high temperatures.

Hold-off Capacitor

When the monostable multivibrator first trips on, it generates a fast-rising, flat-topped pulse. This pulse charges the hold-off tantalum capacitor, C_1, in Fig. 11. Any subsequent pulses due to high-frequency spin rate which appear before the end of the designed hold-off period, will not be able to pass enough current through C_1 to affect Q_7. They will merely recharge C_1.

The discharge resistor in parallel with C_1 may be chosen for the desired time constant. Hold-off times of several hours were available from the rectifier-capacitor combination used but five minutes was chosen as the most desirable compromise between spin rate and orbital requirements. Capacitor C_1 remains charged throughout the sunlight period. During the dark period, no output appears from the shaper and C_1 discharges gradually. The circuit is then armed for triggering on the first pulse generated at "dawn".

When the first charging pulse hits C_1, the steep wavefront passes through it and is amplified by Q_7. This amplified pulse is then fed through capacitors to the binary which trips to the opposite state. The binary is similar to the shaper except for the method of feed and d-c coupling to all bases to make it bistable.

Buffer transistors are connected in a stacked series configuration to minimize current drain from the binary. With this connection, the binary need supply only the base currents to the first transistor of each stack. Base current for the last transistor in each stack is supplied by the load-circuit supply. This supply is on only a fraction of the time since it is commutated by the telemetry encoder.

Part IV—Micrometeorite Collision Counter

SMALL MICROPHONES mounted on the satellite skin will be activated by collision of the satellite with meteoritic particles of about 10^{-8} grams traveling at speeds of about 60 km/sec with respect to the satellite. Counting rates will probably vary from one particle every ten minutes up to ten particles per second.

Signals transmitted by the satellite will consist of a number of tone bursts separated by blank spaces. Frequencies of three of these tone bursts will be indicative of the cumulated number of impacts detected by the microphones. Frequency of one burst will indicate the unit digit, another the tens digit and a third the hundreds digit of the cumulated count.

A block diagram of the equipment is shown in Fig. 12. The pulse former takes the transistor-amplifier output, a pulse of a few μsec duration, and forms it into a low-impedance signal of constant v-sec value for the counter input. The counter accepts these pulses increasing the output oscillator frequency on receipt of each. The tenth count resets the frequency to a low value.

Amplifier Sections

The first four transistors of the amplifier perform linear amplification upon the microphone outputs. Voltage gain is about 60 db with 3-db response points at approximately 40 and 200 kc. The second section of the amplifier uses a fifth transistor biased to operate as a detector. This section performs pulse-envelope detection, pulse stretching, and differentiation of the leading edge of the stretched pulse.

The third section of the amplifier has a transistor biased almost to cutoff. It amplifies the differentiated stretched pulse to an ampli-

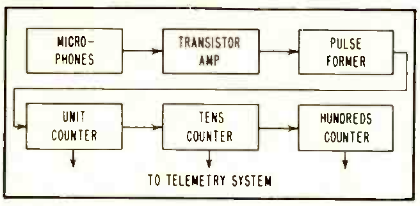


FIG. 12—Block diagram of micrometeorite experiment

tude suitable for driving the pulse former of the counter. This output pulse corresponds in time to the leading edge of the ringing-pulse output from the microphones.

The pulse-former circuit is similar to the resetting circuit described previously in the section on the magnetic-memory readout. The pulse former converts the pulse from the amplifier into a square pulse of 200-μsec length with an output impedance of a few ohms.

Counter Circuitry

Each decimal counter has as its most basic elements, two square-loop-type magnetic cores. These cores remember the last flux level to which they were set. One is a Cyclops core, as described in the previous section on the satellite memory.

One complete stage of counter circuitry is shown in Fig. 13. Core I is a standard square-loop core while core II is a Cyclops. All transistors are used only as switches. The transistors are either fully conducting or fully cut off at all times. The input circuitry forms nine small pulses followed by a tenth large one. At the end of ten counts, the reset circuitry resets the Cyclops, partially completely resets core I, and provides input valtages for the next stage.

Input Circuitry

A schematic diagram of the input circuitry is shown in Fig. 13. Voltages A and D are the square-wave inputs from the pulse former. In actuality, A and D are windings on the pulse-former core or the Cyclops of the preceding stage. Voltage C' is a voltage from the preceding stage that is transformed through a saturable square-loop core (core I of Fig. 13). For counts one through nine, voltages A, D and C' are all present and in the polarities shown. Voltage C' has a magnitude somewhat greater than A. Under these conditions, transistor Q_3 conducts fully while Q_2 is cut off. The 1.3-v battery voltage is applied across the Cyclops after undergoing a drop across silicon rectifier D_1 and resistor R_2.

Upon receipt of the tenth voltage input pulse, the core that has been transforming the voltage C' is saturated. No transformer action takes place making C' zero, while A and D are still present. Both transistors become fully conducting and the 1.3-v battery appears across the winding with only negligible drop. This is the mechanism that allows nine small pulses followed by a large tenth one to appear across the Cyclops winding.

Reset Circuitry

Reset circuitry is shown in the center section of Fig. 13. A large negative voltage spike is developed across the core windings following the tenth input pulse. This negative spike is so large that the 1.3-v battery in the base circuit of Q_4 is over-ridden. A negative voltage appears upon the base of Q_4 and the collector-circuit 4-v battery appears across the windings in the collector circuit. This voltage, in turn, is transformed to the base windings which puts Q_4 even more fully into the conducting state and holds it there even after the initiating kickback voltage has disappeared.

The 4-v battery voltage takes both cores back towards positive saturation—core II directly, core I by coupling through D_2. Core I is designed to have much less volt-sec capacity than core II. Core I goes into saturation when core II has only moved a small way up its hysteresis loop.

When core I goes into staturation, a short-circuit is thrown across both cores due to the coupling. Voltage on the base windings of Q_4 falls below 1.3 v and Q_4 cuts off. The circuit is now ready to receive more counts. During reset, a large negative voltage pulse is developed across the windings. This reset voltage pulse becomes the voltages A, B, C and D for the following stage from the output windings as shown in Fig. 13.

During the interval that a particular oscillator frequency is to appear in the transmitted signal, a gating signal is used to apply oscillator power. This signal turns the appropriate oscillator on for the proper interval. The output terminals go to a modulator that reshapes the somewhat triangular waves of the oscillator into square waves. The square waves then modulate the transmitter. The oscillators of the three stages are tied together in parallel at the points M_1 and M_2 in Fig. 13.

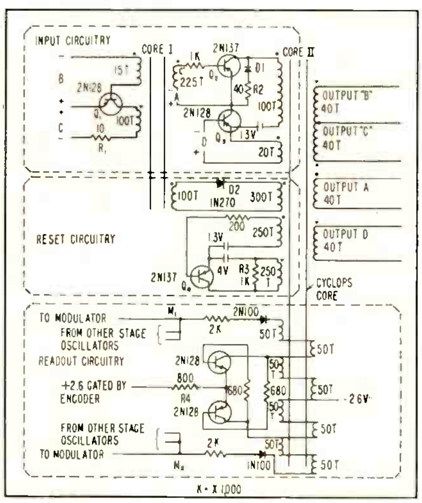


FIG. 13—Complete counter stage

Units have been built that will consistently count to ten and reset over the range from 0 to +80 C. Changes in calibration with temperature do occur, but can be accounted for since the instrument-compartment temperature will be a telemetered quantity. Gain of the amplifier is constant to within 20 percent from −20 to +70 C. Weight of a module which includes amplifier, pulse former, and three counter stages is 3.1 oz before potting; 5 oz after.

Power Requirements

The amplifier requires 1 ma current drain at 4 v. The counter itself has zero current drain when no counts are being received. Approximately 15 or 20 ma flow for each count. This flow lasts for only 200μsec per pulse. A 1,000 ma-hr battery is able to keep the counter counting to over 10^9 counts.

Readout oscillators require about 3 ma of current at 2.6 v but are on only about one-sixth of the total time.

D-C Transistor Amplifier

Amplifier circuit uses double emitter follower and grounded emitter voltage amplifier to obtain input impedance of 0.4 megohm. Adjustable temperature compensation in first stage gives good short term drift stability. Overall current gain is 1,000 and voltage gain is 40. Application is in photocell circuits where signal voltages are not large and output impedance is high

By **DONALD SCHUSTER** Psychological Services, Inc., Los Angeles, Calif.

USE OF DOUBLE EMITTER followers or two cascaded grounded-collector stages to achieve an input impedance between one-half and one megohm in a-c transistor amplifiers is fairly well-known.[1] For d-c amplifiers, however, high input impedance is a problem since there is the added requirement of temperature drift compensation. The circuit discussed here maintains good short term temperature stability while maintaining high current gain.

Drift Compensation

Collector current variation with temperature is the major source of drift in a transistorized d-c amplifier. Another source of drift results from changes in current gain.

The effects of drift can be minimized, but not completely eliminated by appropriate bias stabilization or by negative voltage or current feedback. In practice, bias stabilization is difficult to maintain for d-c signals and negative voltage feedback is conducive to decreasing the input impedance. Since negative current feedback is practically feasible and increases the input impedance, it is used to compensate for drift in the circuit described here.

When using a double emitter follower, minimization of the effects of drift with negative current feedback is insufficient. It is also necessary to compensate for or balance out drift resulting from the large overall current gain in the stage.

A practical solution to the problem is to make the compensation adjustable. This is accomplished with a circuit in which one transistor is used as a drift current generator to compensate another transistor of the same type and a potentiometer is used for fine adjustment of the compensation current in a two-stage grounded-emitter amplifier.[2] A variation of this compensation method is the one employed in this amplifier.

The amplifier shown in Fig. 1A consists of a double emitter follower plus a grounded-emitter voltage amplifier. Drift compensation is used only in the first stage. An identical transistor, or almost identical, is used to generate an adjustable out of phase drift current.

Collector cutoff currents I_{co1} and I_{co2} flow from transistors Q_1 and Q_2, respectively. Compensation control R_1 has no effect on the signal when its wiper arm is near the end connected to the emitter of Q_1. As the arm is moved towards the end connected to the base of Q_1, compensation current I_{co2} is multiplied by the current gain of Q_1 which is expressed as $\beta + 1$. In practice, Q_2 is selected to give a compensation current I_{co2} which is somewhat less than I_{co2}.

Readjustment of R_1 is necessary each time the voltage developed across bias control R_2 changes.

Any variation in the driving source impedance varies the bias current in Q_1 thereby affecting the output d-c level. Zeroing control R_3 is added to provide means for zeroing the output since continuous correction using R_1 is impractical.

Battery E_1 consists of a string of five series connected RM-400R

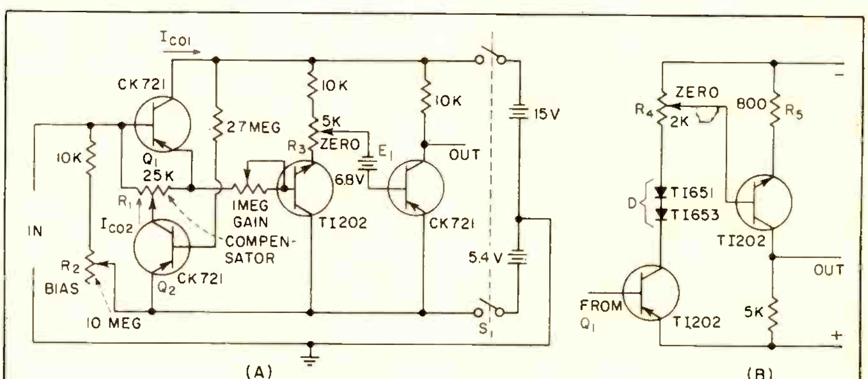
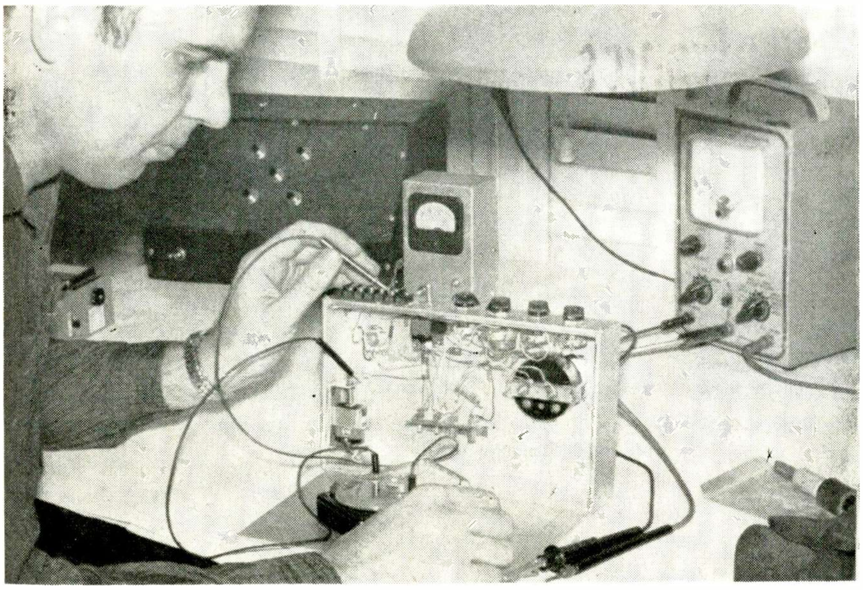


FIG. 1—Complete high-impedance d-c transistor amplifier circuit (A) has battery coupled output stage. Alternate output circuit (B) eliminates battery through use of Zener diode

for High-Impedance Input



Applying signal from cadmium sulphide photocell to high-impedance d-c transistor amplifier. Output is used to operate timing circuit relay

mercury cells. When power switch S_1 is open, the current flow through E_1 is approximately three microamperes; when S_1 is closed, the current reverses and battery E_1 recharges while the amplifier is in use. If the amplifier is continuously inoperative, it takes several thousand hours to discharge E_1 completely since an RM-400R has a rated capacity of 80 milliampere hours.

An alternate output arrangement that operates without battery E_1 is shown in Fig. 1B. Additional signal losses occur in this circuit which result from the possible variable voltage drop across Zener diode D, the voltage divider action of zero control R_4 and resistance of emitter resistor R_5. To increase gain, replace R_5 with an appropriate Zener diode.

Adjustment

Since all controls interact to some extent, they should be adjusted after the preliminary zeroing procedure to establish correct current gain. Gain, zero, bias, and compensator controls are set in that order.

Zeroing of the amplifier is accomplished in two steps. First, the input terminals are shorted with a 10,000-ohm resistor and the output voltage adjusted to zero with the zero control. Second, the input short is removed and the output voltage readjusted to zero with the bias control. This zeroing procedure assures a zero output for a zero input at the desired operating characteristics.

Amplifier Characteristics

Amplifier sensitivity is sufficient to use a current change of 0.01 microampere as an input signal. Maximum usable output of approximately 1 milliampere is obtained at 0.1 microampere change.

Overall maximum current gain is 10,000 and the voltage gain is 40. Frequency response is nearly flat from d-c to 15 kc where it is down 3 db.

Direct measurement of input resistance is impractical since an ohmmeter overloads the voltage ampliying capabilities of the amplifier. Therefore, measurement is made by applying a known reference voltage across a variable resistor connected to the input terminals.

Initially the variable resistor is set at zero, and the reference voltage gain at the output terminals measured. Then the variable resistor is advanced until the reference voltage gain becomes half its former value. The amount of ohmic increase represented by the change in the variable resistor setting is equal to the amplifier input resistance.

Using this method, the a-c input impedance for the amplifier was found to be 0.4 megohm. A dynamic check using an R-C method gave essentially the same result.

Short term temperature stability of the amplifier was measured over a fifteen minute interval and found to be five percent. Better drift characteristics are obtainable if both the second and third stage are temperature compensated in a manner similar to that used in the first stage.

Applications

This amplifier is particularly useful whenever it is used with a driving source that develops moderate voltages at high output impedances. Two typical drivers are bioelectric phenomena and solid-state photocells.

Measurements of camera shutter speeds were made using the amplifier to increase the output signal from a cadmium sulphide photocell sufficiently to operate a timing relay circuit. Since the dark resistance of the photocell is approximately 1,000 megohms and the light resistance was between 0.1 and 1 megohm. The amplifier developed an output only when the shutter opened.

For some applications, higher input impedance can be obtained by adding a resistor in series with the input. If this is done, appreciable reduction of current and voltage gains result.

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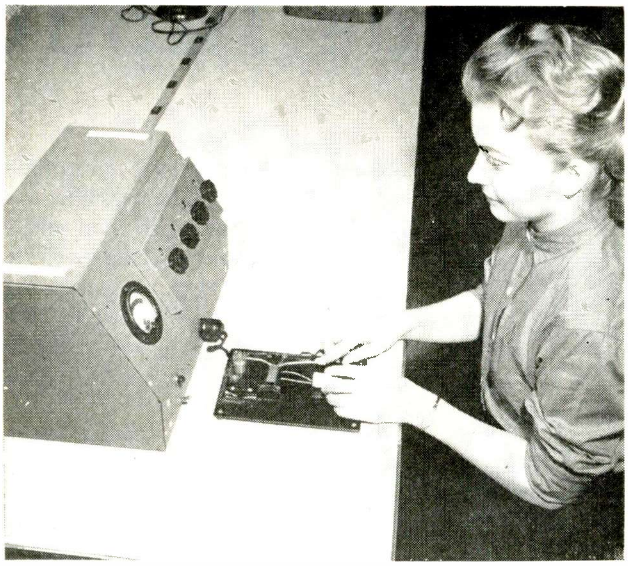
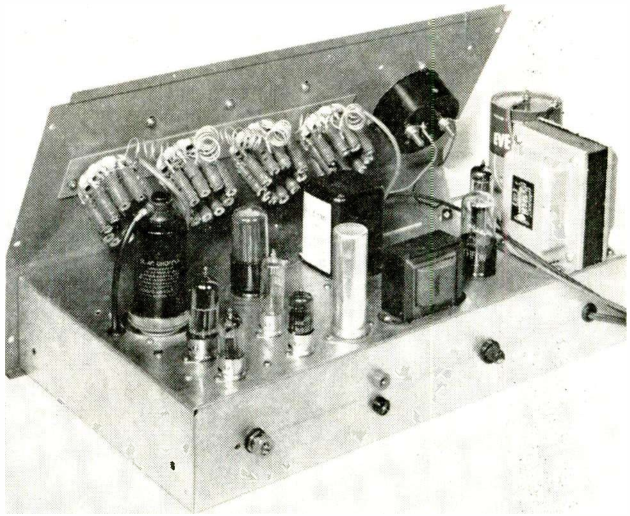


Resistance is quickly checked with a Wheatstone Bridge circuit adapted for go, no-go operation



In usual order are d-c/a-c chopper, amplifier and power supply for resistance checker

Go No-Go Meter Speeds

Amplified error voltage from a Wheatstone bridge feeds 75-0-75 microammeter to indicate whether resistance under test is higher or lower than desired value and also if it is within a preset tolerance. Instrument range is 9.999 ohms in one ohm steps

By DONN S. RANDALL, Technical Writer, Stevens-Arnold, Inc.

A GO, NO-GO RESISTANCE measuring instrument, which does not require dial adjustments, permits rapid testing by nontechnical personnel is described. Conventional Wheatstone bridge test circuits which require adjusting calibrated resistors until a detector indicates a null and then reading the dial settings to obtain the unknown resistance value are satisfactory for small quantity testing. However, when checking the resistance of a large number of components, a meter with a go no-go indication is desirable.

The instrument described requires no dial turning to determine whether the resistance under test is within or outside preset limits. A Wheatstone bridge is employed but without the necessity of achieving a precise balance to take a reading. Instead, the developed d-c error voltage is modulated, amplified, and demodulated; the resulting amplified d-c deflects a 75-0-75 microammeter to indicate whether the resistance under test is higher or lower than the nominal value and whether it is within or outside the established limits.

Instrument Operation

Figure 1 is a simplified schematic showing how the instrument operates. A double-pole a-c/d-c chopper with make-before-break contacts uses one pole to compare the voltage drop across arm *AC* of the bridge with that across arm *BC*, and the other pole as a half-wave rectifier for the meter. Any difference between the voltages is fed to the grid of the first amplifier tube, Fig. 2, as a square wave. Phase of the square wave depends on whether voltage across *AC* is greater or less than voltage *BC*. Voltage amplitude is determined by the magnitude of their difference. Since pole 2 of the chopper is always in step with pole 1, the polarity of alternate half waves reaching the meter is controlled by the phase of the amplifier input signal. The meter will therefore indicate whether the resistance under test is higher or lower than the standard.

Since the amplitude of the half waves governs how far the meter deflects, the instrument can be set

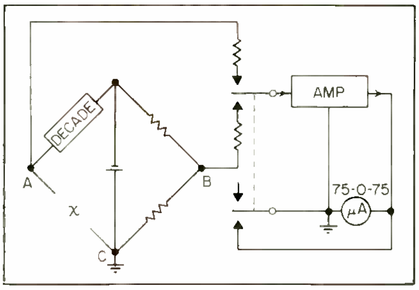


FIG. 1—Error voltage developed across *AB* is amplified and fed to a 75-0-75 microammeter

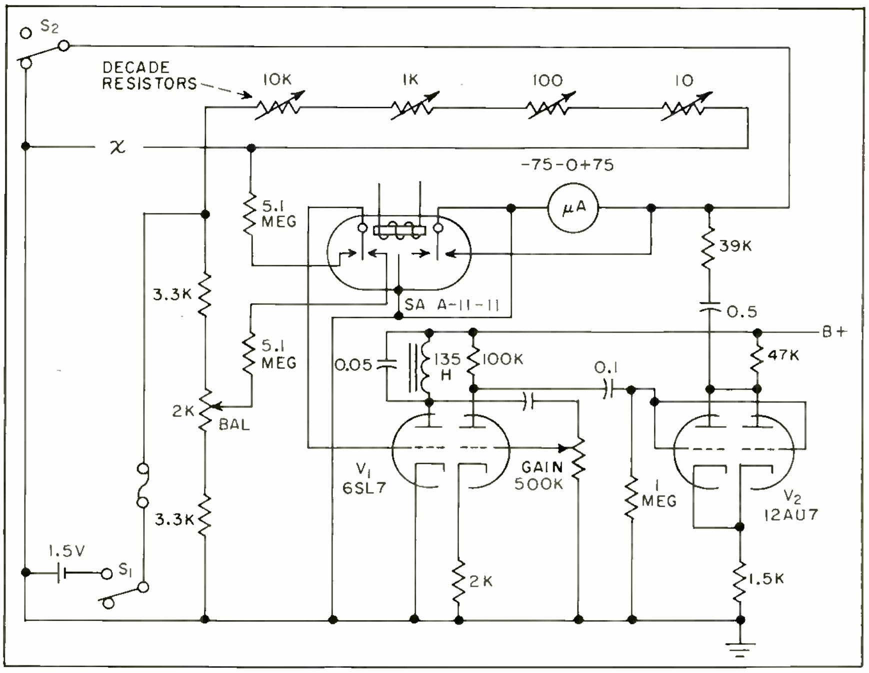


FIG. 2—Direct-current error voltage is modulated, amplified and demodulated. The resulting d-c deflects microammeter to indicate whether resistance under test is within tolerance limits

Resistance Check

for different tolerance limits by simply adjusting the amplifier gain control. If desired, amplifier gain can be left constant and meter calibrated in percentage.

Calibration

The meter scale is divided into thirds with the middle third painted green for GO and the extreme thirds red for NO-GO. The left red section is marked LO and the right red section, HI.

Voltage control and gain control are set at minimum, and the line voltage turned on to allow the equipment to warm up for several minutes. Plate supply voltage is set at 210 v with the voltage control. A decade resistor is connected to the x terminals and both it and the built-in decade set to the same value, say 1,000 ohms. The meter shorting switch S_2 is opened and the gain control advanced until the meter pointer moves a good distance off zero. The pointer is then returned to zero by careful positioning of the balance control.

When adjusting the meter it must be taken into account that a value of x a given percentage higher than the decade resistor will not produce as great an error voltage as a value of x which is the same percentage lower (Fig 1). This percentage variation is a fundamental characteristic of the bridge. It is easily dodged by the proper technique.

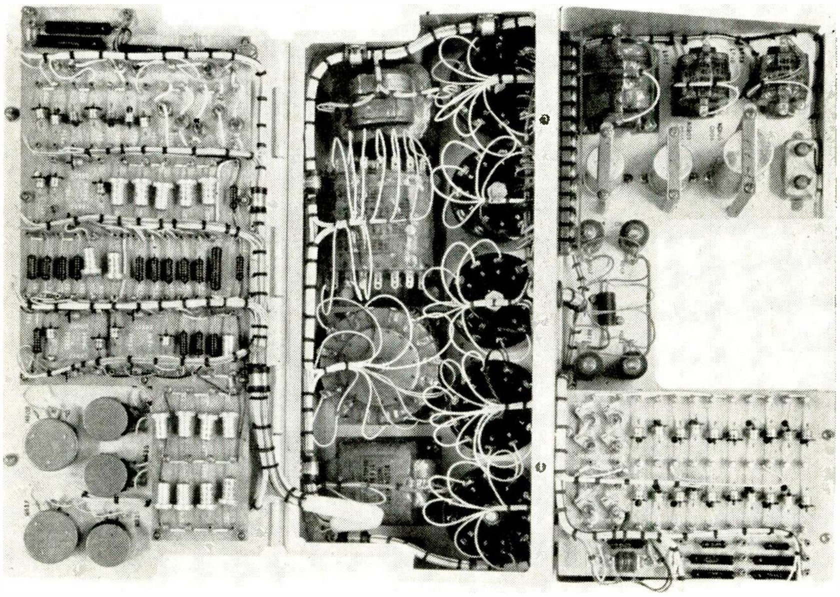
With the built-in decade set at 1,000 ohms and the external calibrating decade set at 1,100 ohms, amplifier gain is adjusted until the meter pointer reads at the go, no-go division on the HI side. Switching the external decade to 900 ohms, causes the pointer to read in the red LO region. The distance between the pointer and the LO go, no-go division is noted and amplifier gain reduced until this distance is halved; then, with the meter zero adjustment, the pointer is moved until it rests exactly on the LO go, no-go division. The external decade is then switched to 1,100 ohms to check the HI reading.

If necessary, the procedure is repeated until the meter indicates both limits correctly. With the external decade set at 1,000 ohms the pointer will rest slightly to the HI side of center. This slightly high zero reading will not affect the accuracy of the instrument since the purpose is to determine if the resistance is between high and low limits. The instrument will check resistance within the range of its decade to a tolerance of ±10 percent.

Accuracy is checked at several points in the operating range. When set for ±5 percent limits, accuracy is maintained within pointer width over the entire range. With suitable external calibrating resistances any symmetrical tolerance limits can be obtained by adjusting amplifier gain to give the required meter deflection.

Test Fixture

The test fixture clamps the leads of the component to be tested and opens normally closed microswitch S_2 to activate the meter all in one operation. In this way meter slamming is held to a minimum. Three brass blocks slide on Bakelite tracks and are held apart by small coil springs. Bakelite separators prevent the springs from shorting the blocks. The x leads are connected underneath to the two blocks nearest the switch. One side of the switch is connected to the grounded x lead and the other to the hot side of the meter.



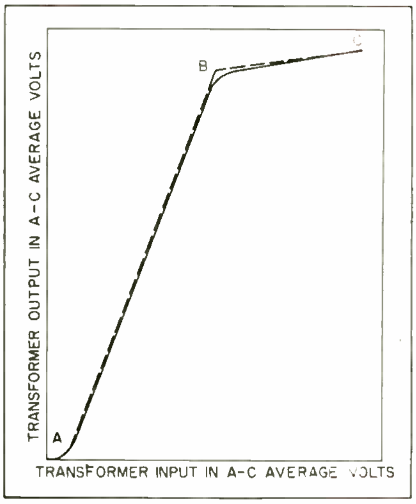


FIG. 1—Transfer function of saturating transformer

Hinged-leaf packaging conserves space, affords access. Vibration mounting also used

Magnetic Amplifiers Regulate D-C Supply

Magnetic amplifiers combined with saturating transformer maintain output regulation well within three percent when supply voltage varies in steps of as much as 20 v. Silicon rectifiers in bridge configuration convert a-c supply to d-c output at five levels from −50 to +500 v. A single magnetic amplifier can meet smaller requirements by regulating in the primary winding of the saturating transformer

By M. B. MEUNIER Design Engineer, Westinghouse Electric Corporation, Electronics Division, Baltimore, Md.

MAGNETIC REGULATION of a d-c power supply will permit meeting stringent transient requirements in addition to giving good steady-state regulation. One of the prime considerations in the design to be described is minimization of weight and volume.

Included among the specific requirements for this system are a supply voltage of 115 v ± 10 percent at 60 cps ± 5 percent. Ambient temperature must be in the range from 0 to 50 C.

The most difficult requirement to meet is the transient requirement for step changes in line voltage. A conventional magnetic amplifier regulates the normal variations in supply voltage and frequency within the limits imposed by the specifications, while a saturating transformer preceding the magnetic amplifier handles rapid transients.

The transfer function of the saturating transformer appears in Fig. 1. This curve may be approximated by two straight lines as shown. By operating on the portion of the curve between points *B* and *C*, and by driving the transformer into saturation on both the positive and negative half-cycles, the transformer will support a given number of volt-seconds during each cycle and maintain a constant average output voltage at a fixed frequency. As long as the input voltage doesn't exceed the range *B-C* in Fig. 1, little transient effect appears in the output.

The overall circuit is shown in Fig. 2. Inductor L_1 is the current-limiting choke and T_1 is the saturating transformer. The voltage waveform across the primary of the saturating transformer is shown in Fig. 3A. Area *A* in Fig. 3B is cut from the input wave by the transformer when it saturates at points 1 and 4 in the cycle. At these points current in the transformer builds up rapidly as shown in Fig. 3C and is limited only by the input choke.

At point 2 in the cycle the line voltage reverses polarity and the saturating transformer attempts to absorb voltage. This is opposed by the input choke's attempt to maintain current flow. As a result the saturating transformer cannot begin absorbing voltage until the current reduces to zero at point 3. At this point the transformer assumes the value of the line voltage and shaded area *B* is also cut from the input waveform.

The remaining voltage is now transformed to obtain the necessary voltage for each supply. This is done in the three low-voltage supplies by adding three secondary windings directly to the saturating transformer, thereby utilizing all the available space.

The two high-voltage supplies are fed from a separate transformer T_2. This transformed voltage is then rectified by bridges CR_1 through CR_7, and the magnetic amplifiers absorb part of this voltage to maintain the regulated outputs. In regulating the average value of the rectified voltage the magnetic amplifiers in the three low-voltage supplies absorb a portion of the wave as shown by the shaded area in Fig. 4A.

High Voltage

The two high-voltage supplies are each fed from two windings on transformer T_2. Those which feed rectifiers CR_6 and CR_7 supply about 75 percent of the voltage while the remaining 25 percent is supplied by the windings feeding CR_4 and CR_6. By dividing the voltage in this manner and connecting the magnetic amplifier in series with the lower-voltage winding, only a small portion of the total voltage is regulated and the peak voltage appear-

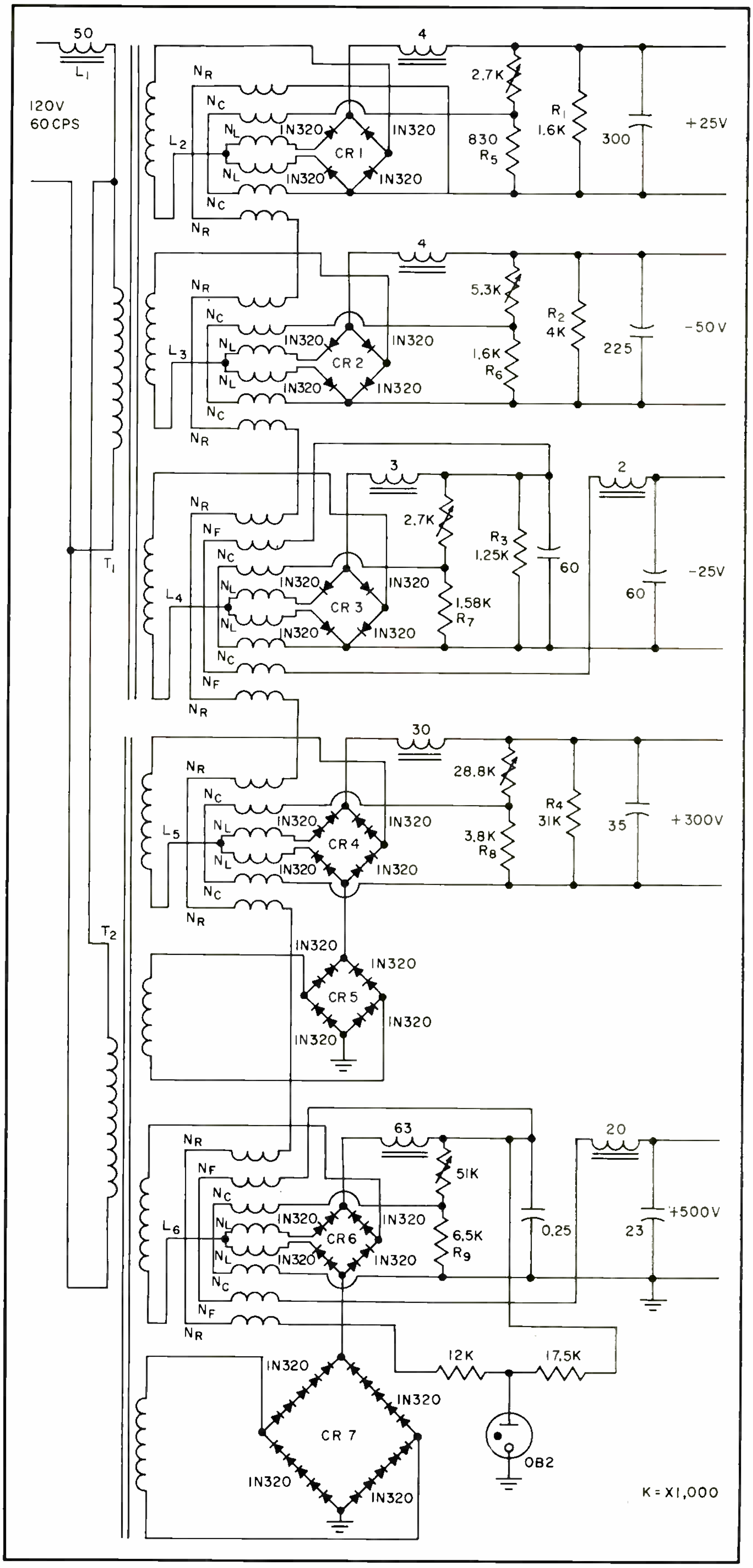


FIG. 2—Overall schematic of high-voltage magnetically-regulated power supply connecting bridges as shown allows voltages of the two windings to be added

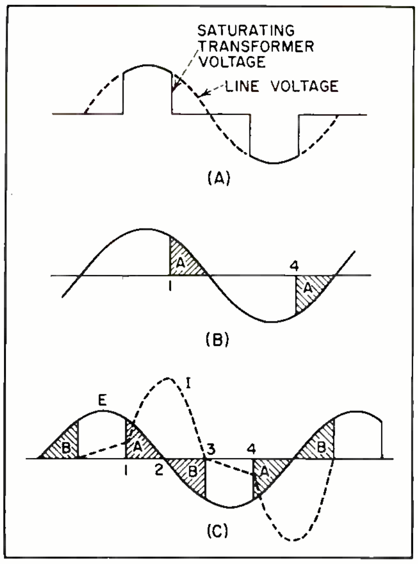


FIG. 3—Waveform (A) across primary of saturating transformer. Shaded area (B) is cut from input wave when saturation occurs at points 1 and 4. Under these conditions current in the transformer (C) builds up rapidly

ing across the magnetic amplifier is the peak of the smaller winding only. Thus the magnetic amplifier need not be insulated for the full voltage, which is 1,500 v for the 500-v supply due to the narrow pulse which must be used, and the size of the magnetic amplifiers for these two supplies is kept to a minimum. The voltages of the two windings are added by connecting the two bridges shown in Fig. 2.

In regulating the average value of the rectified voltage, the magnetic amplifiers in the two high-voltage supplies absorb a portion of the wave as shown by the shaded area in Fig. 4B. Since better regulation and lower peak ripple values are required on the −25-v and +500-v supplies, a higher gain is required of the magnetic amplifiers on these than on the other three and two-stage filtering is necessary for stability.

The reference voltage for all the magnetic amplifiers is supplied by a v-r tube in the 500-v supply, reference windings N_R being connected in series as shown in Fig. 2.

Bleeders R_1 through R_4 protect the filter capacitors in the event that loading is removed from the supplies. This is not necessary on the 500-v supply since the v-r tube draws enough current for protection.

Output Compensation

The voltage level of each supply is set by the variable resistors in the control-winding (N_c) circuits. Since two-stage filtering is used on the −25-v and +500-v supplies and the control current taken from the output of the first filtering stage, load-compensating windings N_F are added to the magnetic amplifiers on these supplies. The load current flowing through these windings tends to compensate for the changes in IR drops in the second-stage filter chokes with changes in load.

Temperature compensation is also added to the magnetic amplifiers because of the series-connected reference windings, which make a large portion of the reference-circuit resistance copper resistance. The reference and control circuits use low-temperature-coefficient resistors. Since the reference voltage is fixed, any change in the copper resistance of the reference windings due to temperature will affect the reference current and consequently the regulated output. To obtain perfect compensation the resistance of the control and reference circuits must vary together, so the ratio of copper-to-stable resistance in the control circuit is equal to the ratio of copper-to-stable resistance in the reference circuit.

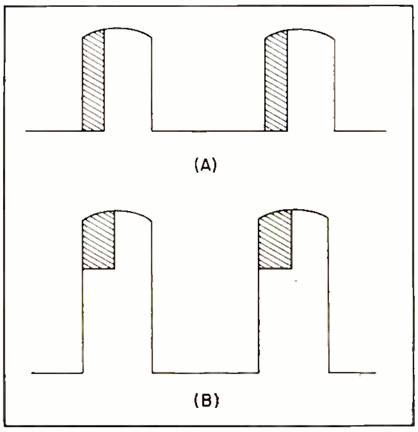


FIG. 4—In regulating average of the rectified voltage, magnetic amplifiers in low-voltage supplies absorb shaded parts of waves (A). In high-voltage supplies absorption occurs as in shaded portions of waves (B)

One simple method of establishing this ratio equality is to add stable resistors R_5 through R_9 in parallel with the control windings. This has the effect of increasing the copper resistance of the winding across which the resistor is connected.

Saturating transformer T_1 is designed to support 76 v rms and is wound on a 2-mil strip Hipernik V core 2 in. inner diam × 3 in. outer diam × 1 in. Winding data appears in Table I.

Saturable reactors L_1 through L_5 are wound on 2-mil strip Hipernik V cores 1½ in. inner diam × 2 in. outer diam × ¼ in.

Table I — Coil-Winding Data for Power Supply Transformers and Inductors

Unit	Winding	Volts	Amperes	Turns	Wire Size	Resistance in Ohms	Size in Inches	Weight in Pounds
T_1	Pri	72	0.443	416	20	2.35	3¾ × 3¾ × 3 high	2
	S_1	238	0.102	1,375	36	262		
	S_2	143	0.109	830	36	44		
	S_3	138	0.064	800	36	176		
T_2	Pri	72	1.15	360	21	3.84	4 × 4⅝ × 4¼ high	4.9
	S_1	273	0.089	1,340	32	102		
	S_2	334	0.089	1,640	32	159		
	S_3	251	0.036	1,230	36	303		
	S_4	725	0.036	3,549	36	966		
L_1 L_2 L_3	N_L	56	0.05	2,430	34	137	3 diam × $3\frac{5}{16}$ high	2
	N_{c1}		0.01	850	36	81.6		
	N_{c2}		0.01	850	36	84		
	N_{c3}		0.01	1,700	36	175		
	N_F		0.1	18	36	1.31		
L_4 L_5	N_L	167	0.05	7,300	36	681	3 diam × $3\frac{9}{16}$ high	2.5
	N_{c1}		0.01	3,500	36	377		
	N_{c2}		0.01	3,500	36	475		
	N_{c3}		0.01	7,000	36	997		
	N_F		0.1	180	36	5.94		

Word Generator for Digital Testing

Beam-switching tube supplies arbitrary nine-bit words at pulse rates from a few cps to one mc for testing and evaluating digital systems. Pulse shape can be varied from spike to square wave by changing plug-in capacitors

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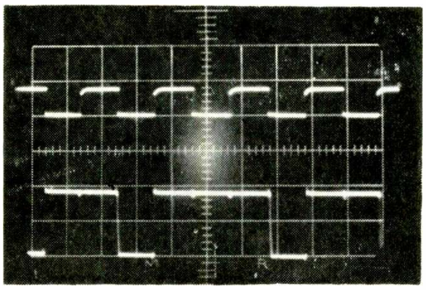
SIGNAL GENERATORS capable of supplying an arbitrary arrangement of square pulses are useful in testing and evaluating digital systems.

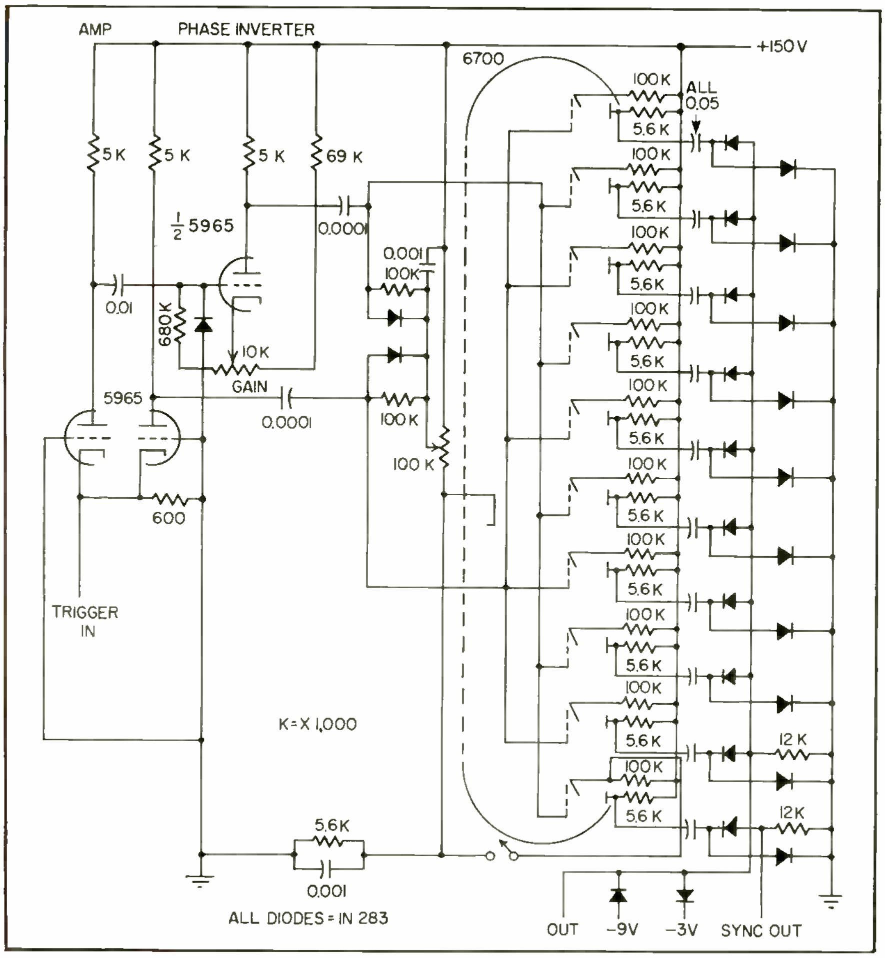
A versatile, binary word generator can be constructed by utilizing a beam-switching tube. Such a word generator provides binary words containing any combination of ONES and ZEROS up to a total of nine. Pulse repetition rate is variable from a few cycles to one mc.

Circuit

The circuit was designed to operate from a low-impedance square-wave source capable of supplying negative pulses of at least −30 v amplitude.



Input to word generator is 400-kc square wave (upper trace). Output with two plug-in capacitors removed is 110111011 (lower trace)



Output from each element of 6700 beam-switching tube is passed through 0.05-μf plug-in capacitor. Removing a capacitor provides a zero output

The first stage of the word generator as shown in the circuit diagram consists of a 5965 dual triode which is cathode driven to provide a low-impedance trigger input. The output of one section of this triode is coupled through a d-c blocking capacitor to one grid of the beam-switching tube. The other section is fed to a phase-inverter which inverts the pulse and applies it to the other grid of the beam-switching tube. The resulting push-pull signal on the grids of the beam-switching tube may then be balanced with the gain control in the phase inverter stage.

The output of each switch-tube target, except number zero, is fed through plug-in capacitors to a non-additive diode mixing circuit. Output pulses may be shaped by changing the value of the plug-in capacitor. A smaller value will give a short differentiated pulse, while larger values give full-length square pulses.

Miniature Ferrite Tuner

Rotary-axial tuner consists of two pairs of ferrite cups with ground D-shaped center cores ganged to produce linear frequency variation from 500 to 1,600 kc with mechanical motion. Operating frequencies can be extended to 15 mc. Tuning sensitivity is reduced as each band is covered in 270-degree rotation rather than in the 180 degree of normal capacitor tuning

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M. LAFER, Chief, Mechanical Design Department

GROWTH IN TRANSISTOR use has spurred the search for miniature electronic devices.

Miniaturization of an r-f tuner operating between 0.5 and 50 mc can be achieved with permeability rather than capacitance tuning. Further, permeability tuning is free from vibration and shock troubles. A linear, permeability type tuner is described for which a 3 to 1 frequency range, maximum Q and minimum variation of Q with frequency are assumed to be desirable.

Gap Tuner

Present tuners may be classified as slug tuners, gap tuners, variometers and those that vary the number of turns on a core.

A permeability gap tuner is the best compromise between electrical and mechanical considerations. It uses the relative motion of two ferrite cups or a ferrite cup and cover plate or two C-shaped cores. Although the core material is always within the coil, the inductance is varied by changing the size of a gap in the magnetic-field path.

A gap tuner is shown in Fig. 1A. The tuning technique permits miniaturization since the cover movement does not exceed ⅛ in. for a 3 to 1 frequency range.

Frequency variation with cover movement is nonlinear. A 250-kc change occurs in the first 10 mils of travel, and at the upper end of the band, a 10-mil change may cause a 25-kc shift. A precise mechanical drive system is required to control the complete frequency range in a ⅛-in. travel.

Another gap tuner is shown in Fig. 1B. The center section of the cups has the shape of a D. Rotation of one cup with respect to the other changes the effective gap length. Frequency changes of 2 to 1 are feasible with this device. Furthermore, since the complete frequency range covers a long rotary path the mechanical drive system is not critical.

The rotary-axial gap tuner takes advantage of the slow frequency variation of the D-type tuner and the wide frequency variation of the cup and cover-type tuner. It consists of two pairs of ferrite cups with ground D-shaped center cores.

Tuner operation is described in the curves of Fig. 2. Curve 1 is the frequency response obtained upon rotating two ferrite-cup cores with D-shaped center cores without gap separation. Frequency initially varies slowly as the cups are rotated, increases to a maximum when the D figures are mirror images at 180 deg and then decreases slowly. The curve is bell shaped.

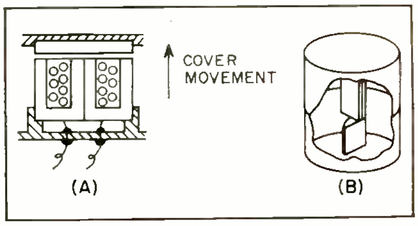


FIG. 1—In gap tuner (A) inductance is varied by changing gap size in magnetic-field path. Rotation of one cup of D-type tuner (B) with respect to the other changes length of the gap

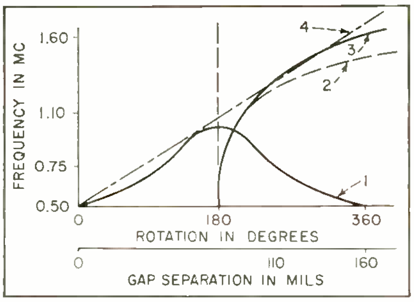


FIG. 2—Curve 4 is the linear frequency response of the rotary-axial tuner obtained by combining responses of curve 1 for D-shaped center cores without gap separation and curve 3 for a tapered coil within the core

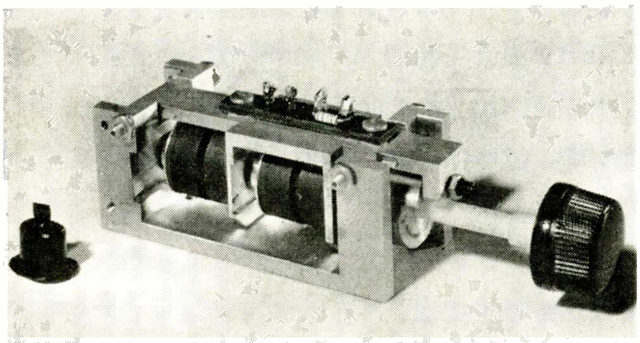
When separating two ferrite-cup cores without rotation, curve 2 is the frequency response obtained. The frequency varies rapidly and then reaches a point where increased gap separation has no effect.

When a tapered coil is used inside the core, the frequency response of curve 3 is obtained. Saturation frequency is 100 kc higher than in curve 2.

Composite curve 4 is obtained when both rotation curve 1 and axial-movement curve 3 are combined by a cam. Since the gap separation is small, rotation of the cup initially exerts the greater control over frequency. Therefore, the frequency varies comparatively slowly.

During the first 250-kc change there is a long mechanical path of

Covers Broadcast Band



Rotary-axial tuner size is indicated by comparison with transistor

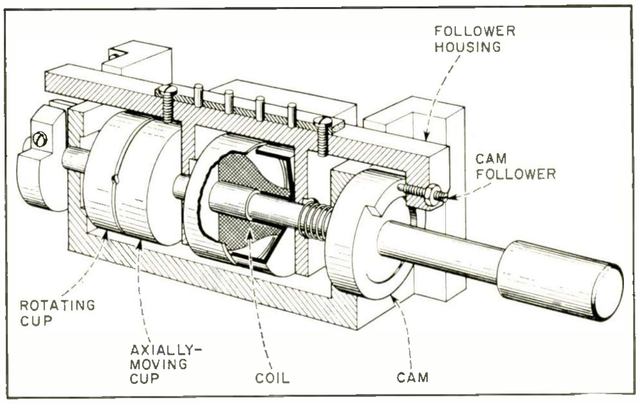


FIG. 3—Cutaway view of rotary-axial tuner shows parts

rotation rather than a short mechanical path of axial movement. As the cups are rotated 180 deg with respect to each other, the gap separation increases until the D-shaped center-core separation no longer affects the frequency change. Thus, the right half of the bell-shaped curve has no effect on the frequency. Beyond 180 deg the frequency change results from gap separation, although the cups continue to rotate with respect to each other. The resulting curve 4 has a linear frequency variation from 500 kc to 1,600 kc.

By further tapering the coil the frequency range may be extended linearly to 1,700 kc. Maximum possible Q is 151.

Mechanical Description

Axial motion of the cups is caused by the cam shown in the tuner drawing of Fig. 3.

A cam follower is in contact with the cam. After adjusting the cam follower to provide initial positioning, it becomes a fixed element of the follower housing and provides linear movement of the axial cups in accordance with the cam form.

Linear motion of the axial cups without backlash is provided by a spring.

The portion of the shaft which is in the immediate area of both rotating and axial cups is made of a dielectric material.

Three-point tracking of the r-f coil is obtained by placing shunt and series coils, together with a new tuning capacitance, in parallel with the r-f coil. A 2 to 1 oscillator-frequency range results. The oscillator tuning follows the r-f tuning curve as shown in Fig. 4.

To show the application of the tuner to transistorized circuits, the tuner r-f coil is connected by a capacitance divider to the input of the transistorized mixer circuit shown in Fig. 5. Mixer output is fixed tuned with a coil resonant at 455 kc. The oscillator coil of the tuner is connected through two trimmer coils to the collector of transistor Q_2 which acts as a Clapp oscillator. The oscillator signal is capacitance-coupled to the emitter of the mixer stage. After making adjustments for stray capacitance, the tuner operates with the linearity and tracking characteristics of Fig. 4.

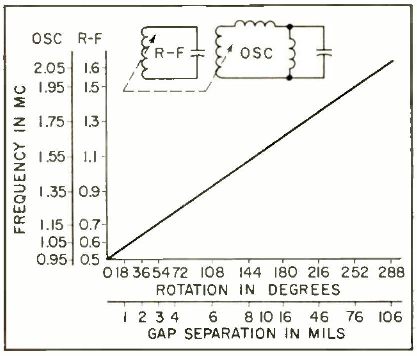


FIG. 4—Straight-line tracking is achieved with rotary-axial tuner

Tuners covering the ranges 1.5 to 5 mc and 5 to 15 mc have the same frequency slope as the broadcast-band tuner, and therefore can be used with the same cam. When

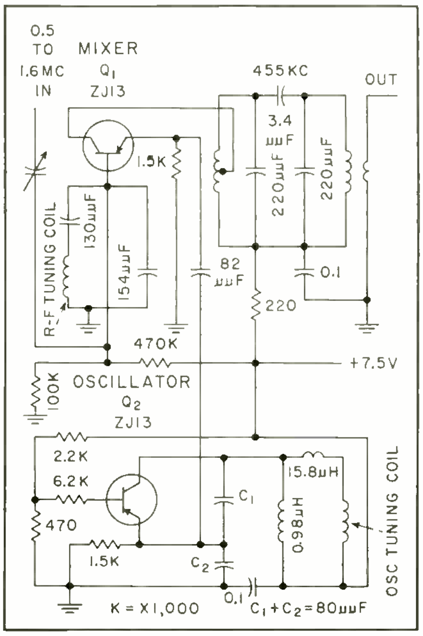


FIG. 5—Transistorized circuit checks r-f tuner whose linearity and tracking characteristics are shown in Fig. 4

the coils are successively tapped down after each rotation of the cam, a semicontinuous tuner can be constructed. A coil wound with several taps is placed in ferrite cups and tested in an r-f tuning jig. The bands from 0.5 mc to 1.5 mc and from 1.5 mc to 5 mc are easily covered by tapping down the coil. The highest band shows an upper-frequency limit of 7.3 mc. The total frequency ratio obtained is 14.6 to 1 with the same tuner.

The aid of Capt. C. Green and G. Tarrants in this work, done under contract No. AF 33(600)-31464 is acknowledged.

Continuous counting chain, recycling every 24 hours and driven by standard frequency input that establishes absolute time, uses eight beam-switching tubes. Absolute time readings are given upon arrival of readout voltage pulse. Actual time of occurrence of a particular event or series of events is displayed in hours, minutes, seconds and tenths of a second. Technique can be adapted for frequency measurements, preset counting and internal timing with input rates approaching 1 mc

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Electronic Clock Reads

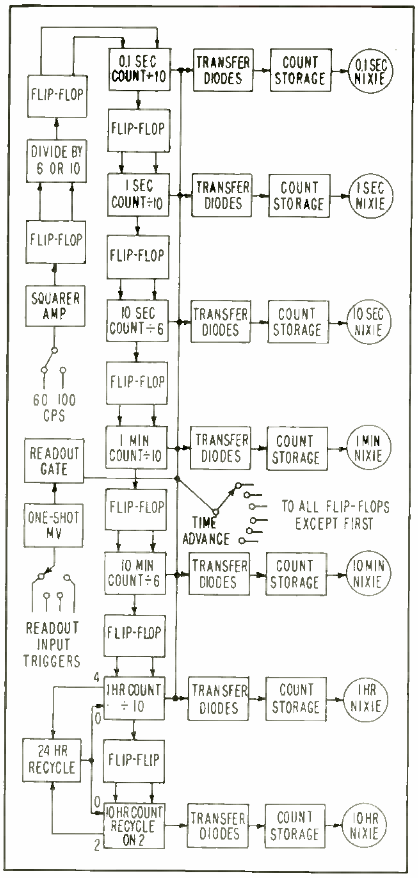


FIG. 1—Complete functional diagram for time-of-event indicator. Standard frequency input signals are used and manually selected depending on frequency division required. First divider converts standard input of 60 or 100 cps to 10 cps to correspond to the minimum unit of time displayed. Additional dividers are cascaded to provide the remaining units of seconds, minutes and hours

TIME-OF-EVENT INDICATORS are electronic counters that visually indicate progression of the count (time).

Counting is independent of the visual display system. Once the counter is on-time, any number of time readouts may be taken without disturbing the counter. Visual indication is effected by first duplicating and storing the particular count position corresponding to that in each of the counter stages at the time of readout, and then firing the corresponding numerals in the glow-discharge visual indicator tubes. This numerical reading as well as the stored count positions are retained until another time reading occurs. Then the new count positions are duplicated and stored and the new numerals fired, the previous ones being turned off in the process.

The equipment to be described was developed for use as a link in an overall computing system for the accurate measurement of geographic position. Celestial navigation methods employed required coordinated time readings of star sightings as well as other related events. Time readings presented are manually inserted into the computer system for further automatic processing.

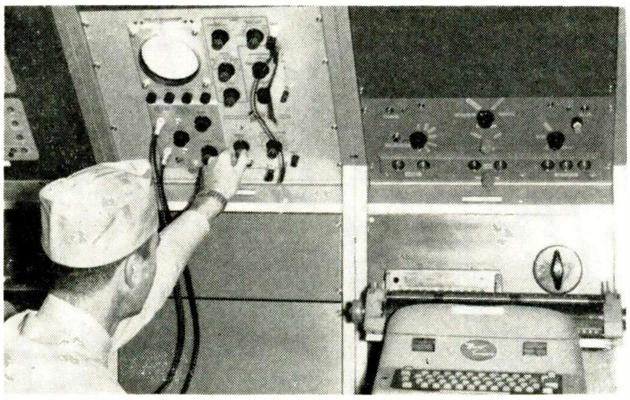
Primary specifications call for an accurate visual time display, a frequency standard, continuous counting without recalibration between successive time readings, and a time calibration source. Two instruments are needed, one to indicate solar time and one for celestial time.

Units of time are displayed in 0.1 sec, 1 sec, 10 sec, 1 min, 10 min, 1 hr and 10 hr with provision for automatic recycling of the counter every 24 hr.

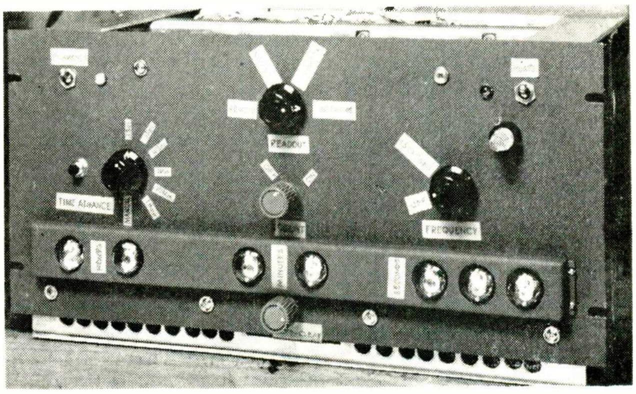
To establish a standard time interval a GR type 1100 frequency standard is used. Crystal frequency adjustment is made by comparison with transmissions from WWV. Frequency dividers convert this basic crystal frequency to 100 cps and 60 cps, which are the standard is used. Crystal fredrive the solar time-of-event indicator.

Requirements

Any possible resetting or recalibration between successive time readings has to be eliminated. That is, upon the occurrence of a particular event, a time reading would appear on the numerical indicators. This reading would remain until a subsequent event produces a new time reading. No adjustment or resetting of the time-of-event indicator should be required before the next event occurs. This feature makes the indicator available for



Operator is shown adjusting controls of equipment that is part of overall computing system where time-of-event indicator is used. Indicator (clock) is shown mounted at the right and provides time readings of star sightings and other related events



Time-of-event indicator is an electronic clock. Instrument displays actual time of occurrence of a particular event or series of events while internally counting progression of time. Absolute time of an event is displayed until next event occurs

Related Time-of-Events

any number of time readings within the long-time recalibration period specified in the program.

Recalibration is required only when the elapsed operating time of the frequency standard is great enough to allow the probable frequency standard's deviation to exceed the allowable time error. The frequency standard will allow several days operation without producing significant error in the 0.1 sec reading.

The standard time interval of one sec provided by WWV time signals is used to phase a 1-cps cam-driven contactor opening. The contactor is driven by a synchronous motor whose power frequency is derived from the frequency standard through frequency dividers. Periodic opening of the contactor can be phased manually to coincide with the commencement of the 1-sec time interval signals from WWV. This can be done within about 5 millisec.

Block Diagram

Figure 1 shows the complete functional block diagram. Standard frequency input signals are fed to the first divider through a squarer amplifier. The first divider converts various input signals to a basic standard frequency of 10 cps to correspond to the minimum unit of time visually displayed. For the celestial time-of-event indicator, an input of 15 cps is used, requiring a division by 3/2 to yield 10 cps. The indicator uses 60 cps or 100 cps, manually selected, requiring division by 6 or 10, respectively.

After the first divider, additional dividers are cascaded to provide the remaining units of sec, min and hr. Since the indicator is to be used continuously, a 24-hr recycle network is provided. Only the 1-hr and 10-hr dividers are affected since the previous stages are at zero in the normal count progression when recycling occurs.

Frequency Dividers

Figure 2 shows the switching tube in the circuit used for the first divider. When dividing by 6, targets 2, 3, 6 and 7 are left with no return. Under this condition, the beam switching to these target positions is unstable since the target voltage drops below the knee of the target current characteristic as the stray capacitance is charged by target current. The net result is that the beam skips these positions and locks in on the first target with a normal return.

Positions 2 and 3 are skipped with the beam locking in on position 4 and positions 6 and 7 are skipped with the beam locking in on position 8. Since 4 active positions have been eliminated, it now requires only 6 input pulses to return the beam to the initial position. Since the flip-flop changes state once for each input trigger to the flip-flop, the advance of one position in the beam switching tube corresponds to the elapse of one period of the pulse train at the flip-flop input.

As a frequency divider, therefore, the circuit of Fig. 2 divides by 6 when the manual selector switch is thrown to the divide-by-6 position. For division by 10, all targets are returned to +200 v and the beam advances one position for each switching pulse.

On arrival of the first switching pulse, the beam position will be advanced only if the condition is satisfied that a negative pulse is delivered to an odd grid when the beam is in an odd position, or a negative pulse is delivered to an even grid when the beam is in an even position. If this condition is not satisfied, an extra pulse to the flip-flop is required before the polarity is correct and the beam will switch. Thus, a loss or miscount of one pulse can represent as much as a 10-hr error if it occurs in the 10-hr counter. The calibration procedure given here eliminates this possibility.

The celestial time-of-event indicator uses a 3/2 division in the first divider as shown in Fig. 3. Two

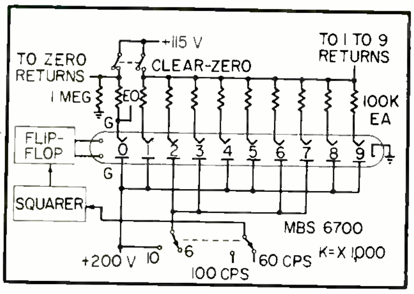


FIG. 2—First divider circuit, divide by 6 or 10, used in solar clock. When dividing by 6, for example, targets 2, 3, 6 and 7 of the tube are open and the net result is that the cathode beam skips these targets and locks in on the first target with a normal return

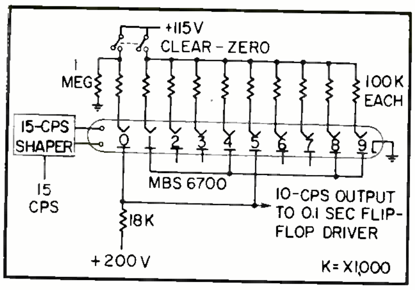


FIG. 3—First divider circuit, divide by 3/2, used in celestial clock. This circuit differs from solar first divider circuit. Output pulse is taken from target instead of spade and switching grids move the beam along at twice the rate with respect to the input frequency

major differences exist between this circuit and that of Fig. 2; the output pulse is taken from the target instead of the spade and the switching grids move the beam along at twice the rate with respect to the input frequency. The switching rate is doubled because the shaper's output reverses each half cycle of the input and therefore twice per period. This action produces frequency multiplication by 2 and the beam switching target circuit arrangement produces division by 3 for a net frequency division by 3/2.

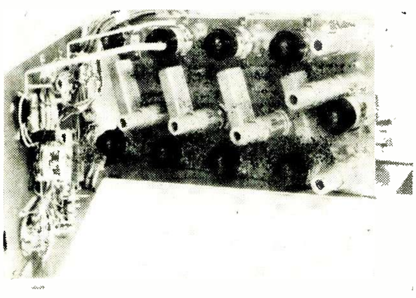
With targets 2, 3, 6 and 7 open as in Fig. 2 the beam skips four positions with a resultant division by 6, with respect to switching grid pulse frequency, if the output is taken from one of the active spades. By taking the output from 2 targets tied together, an output pulse is delivered twice per complete beam rotation, instead of once, reducing net division from 6 to 3.

Two spades cannot be tied together in a similar manner since the beam tends to lock-in on a leading spade and therefore the two tied positions do not behave independently as is the case when the targets are tied. Certain interspade connections may be used for division purposes using this leading-spade lock-in feature.

Automatic Recycling

Figure 4 illustrates the circuitry used to return the hr and 10-hr stages to zero after 24 hours operation. The circuit is a simple cathode follower coincidence circuit driving a relay whose contacts are arranged to clear each divider tube and reform the beam on zero of each tube. When the hr stage reaches four after the 10-hr beam-switching tube has reached its two position, 24:00:000, both grids of the coincidence circuit are near ground potential and the cathode current decreases to a value too low to keep relay K_1 energized. Spade voltage is slightly negative when the beam forms on a spade-target combination.

The relay's contact closes and shorts both zero spade returns to ground. This rapidly clears the beams of both beam switching tubes as no spade-target combination receives cathode current and, therefore, number two and four spades of the 10-hr and hr stages quickly jump to about 5/11 of the spade supply voltage. The coincidence circuit now sees both its grids at high positive potential and the relay reenergizes as coincidence cathode current increases.



Component layout of indicator. Panel is shown open at left

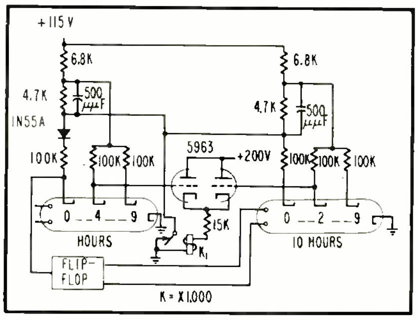


FIG. 4—Circuit used to return hours and 10-hours stages to 0 after 24 hours

Untying the zero spade return circuit from ground, allows the common spade bus for the one to nine spades to rise to the spade supply voltage. Because of the 6,800- 4,700-ohm divider across the spade supply for the one to nine spades, formed when the return is grounded by the relay contact, the zero spade is less positive than all other spades at the moment the ground connections are broken.

In addition, a fractional part of the spade supply voltage set up across the 4,700-ohm resistor is in series only with the zero spade circuit and further serves to keep the zero spade less positive than all other spades. The capacitance across the resistor retards rise of the zero spade to spade supply voltage.

These conditions satisfy the requirements for beam forming from an already formed position, two and four, with the net result that the beams in both the 10-hr and hr beam-switching tubes are formed on the zero spade in stable equilibrium until the next switching grid pulses are received. This completes the automatic recycling.

Addition of the 1N55A to the spade return circuit is necessary to prevent the recycling transient from triggering the flip-flop and causing a one-count error.

Time Readout

Duplicating beam count positions in the various divider stages for visual indication, without interrupting their continuous counting is accomplished with the aid of additional beam-switching tubes. As shown in Fig. 1 these are called count-storage stages. The combined readout and count storage circuit is shown in Fig. 5.

Advantage is taken of pentode-like target characteristic for a free electrode output. At the time of arrival of a readout trigger, a 20-microsecond readout gate cuts off the normal divider target cur-

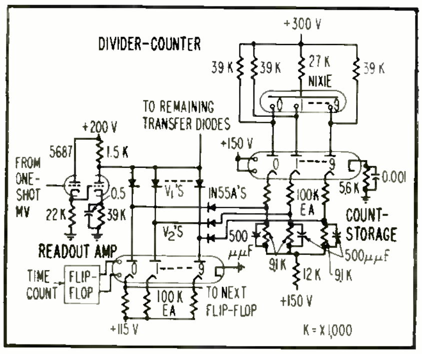


FIG. 5—Combined circuit showing count storage, transfer and readout. Network duplicates and stores beam count positions in various divider stages without interrupting the continuous counting operation and fires numerals

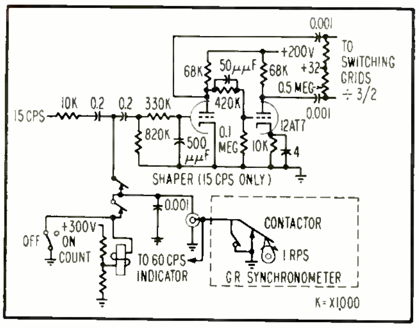


FIG. 6—Calibration input circuit. Calibration consists of setting clock to an arbitrary advanced time setting, shorting standard frequency input pulses to the counting channel and then opening the input at exact time previously set to start continuous counting

rent return through transfer diode V_1 and forces the target current to flow through V_2 to the count storage spade return. This produces a negative pulse on this spade as well as along the entire spade bus because of the 12,000-ohm common spade resistor.

For similar reasons, as outlined in the discussion on automatic recycling, the beam is cleared and reformed on the spade position to which the divider target current is delivered. Since the target current of the count storage stage is connected to the Nixie numerical indicator, the number corresponding to the divider count position at the time of the readout is turned on for a numerical indication of the time count. Note that the count-storage beam-switching tube is not switched, the switching grids being returned to positive potential for stable locked-in operation after beam clearing and forming.

Subsequent readouts clear the beam in the count-storage tube and turn on the new beam position corresponding to the new time count in each of the dividers. Nixie indicators extinguish and refire at the new readings. Readout pulse width may be as short as 1 μsec but was made about 20 μsec for additional reliability resulting from the less stringent amplitude and shape requirements on the diode gate switching pulse.

Calibration

Calibration of the time-of-event indicator consists of setting it to an arbitrary advanced time setting, with the standard frequency input pulses to the counting channel shorted and then unshorting the input at exactly the time previously set on the indicator to start the continuous time counting. The calibration input circuit is shown in Fig. 6. Both the celestial and solar indicators are started by the contactor opening in the Synchronometer. Less than 10 millisec is required for the relay release time.

If the indicator is set for 09:45:000, the contactor must be manually unshorted between 09:44:590 and 09:45:000 or within one second. This will allow only a single contactor opening, normally shorted, corresponding exactly to the commencement of the first second beginning at 09:45:000, to unshort the standard frequency input. Further contactor openings have no effect on the circuit. By watching the second hand, the operator can easily unshort the contactor at the right moment.

Manual Setting

Figure 7 shows the circuits used for manually setting the beam positions in the dividers. After manually forming all the beams in the divider beam-switching tubes by

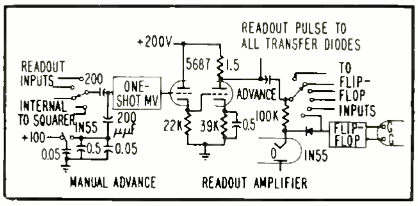


FIG. 7—Manual time advance circuit for manually setting the beam positions in the frequency dividers

shorting the "0" spade returns, the beam positions are manually advanced around in each divider by triggering the flip-flop drivers of a given stage until the arbitrary time setting selected for calibration is reached.

By advancing the beam at least one position before setting it on its calibration reading, the flip-flop is automatically in the proper state to advance the beam in the divider beam switching tube when the first pulse arrives after operation begins. As each position is manually advanced, a readout trigger is delivered to the readout circuits so that the Nixie numerical indicators show the changing beam positions.

The diode between the preceding input spade and the following flip-flop prevents the manually generated pulse from the previous stage from upsetting the beam position which might otherwise advance or clear the switching tube.

Performance

The time-of-event indicator was operated during sea trials successfully for several days of continuous operation without a time error occurring.

The techniques described for the time-of-event indicator may be extended for high-speed operation. Electronic zero-setting within μsec is possible in place of relay zero-setting. Readout transfer time may also be reduced to several μsec. Phasing of the standard frequency input as well as an increase in frequency can be used to further reduce time errors to microseconds.

The opinions or assertions contained in this article are the private ones of the authors and are not to be construed as official or reflecting the views of the Naval Service at large.

Material used in this article was derived from a paper, Electronic Time-of-Event Indicator, presented before the 13th Annual NEC.

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1. J. Bethke, New Applications for Beam Switching Tubes, ELECTRONICS 29, p 122, Apr. 1956.
2. S. Kuchinsky, The Magnetron Beam Switching Tube—a New Concept in Vacuum Devices, Burroughs Corporation paper, Plainfield, N. J., 1955.
3. J. Millman and H. Taub, "Pulse and Digital Circuits," p 339, McGraw-Hill Book Company, Inc., New York, N. Y., 1956.

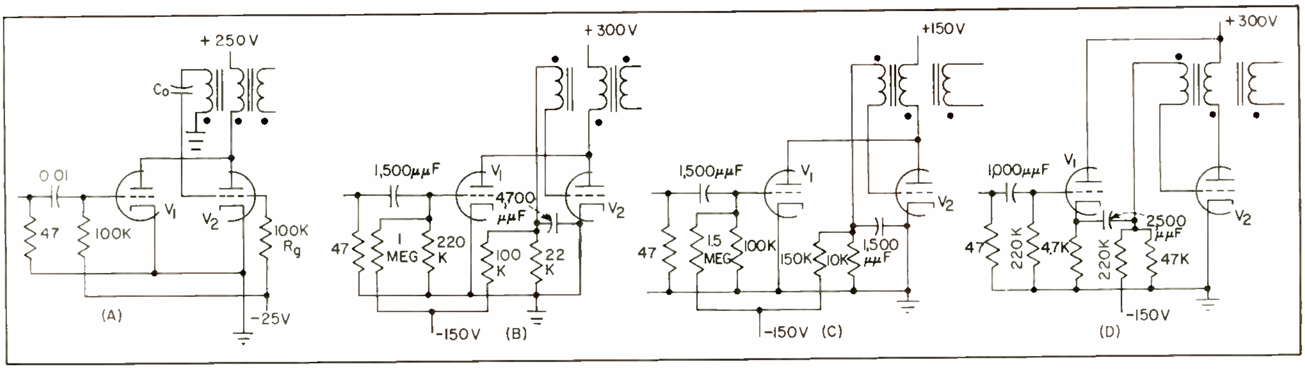


FIG. 1—Four blocking oscillators include standard circuit (A) and three National Bureau of Standards preferred circuits (B), (C) and (D)

Designing Transformers

By R. D. McCARTNEY* Specialty Transformer Engineering, Westinghouse Electric Corp., Greenville, Pa.

CONTINUED MINIATURIZATION of electronic equipment has necessitated the redesign of many standard electronic components including transformers, essential elements in blocking oscillators.

Sufficient data on blocking-oscillator circuits, tubes and specifications have been accumulated to design new transformers with considerable reduction in size along with improved performance. Accurate prediction of output pulse shapes is also possible.

Test Procedure

Four test circuits shown in Fig. 1 provide data from which the pulse-initiation and pulse-width curves needed to design the new transformers are constructed. Since most tubes in use in blocking oscillator circuits are receiving double-triode types, curves for common types 5687, 5965 and 5814 WA are presented. Trigger voltage is set at minimum width and amplitude for all circuits to avoid distortion of the output pulse.

Data is obtained in two steps. First, a set of single-coil, single-core test transformers is constructed. The coil contains plate and grid windings with the turns ratio between the windings varying in steps from 3 to 1 to 1 to 3. The load is connected directly across the grid windings. Type L-1 cores are used with a constant number of plate winding turns for all units.

After inserting the transformers in the test circuit, the amplitude of the pulse appearing across the load resistor is recorded as the load is varied. The resulting pulse-initiation curves of Fig. 2 indicate a turns ratio for maximum power output of each load conductance. From Fig. 2 the designer can predict the output amplitude and select the optimum turns ratio for any value of load impedance.

Secondly, a set of transformers is constructed with various turn levels for each turns ratio at which pulse-width curves are desired.

* Now with Motorola

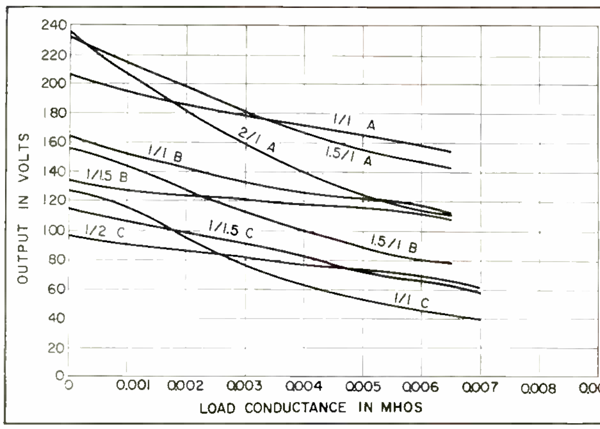


FIG. 2—Pulse-initiation curves *A* are for tube-type 5687, *B* for 5965 and *C* for 5814 WA. All indicated ratios are grid turns/plate turns on a single coil

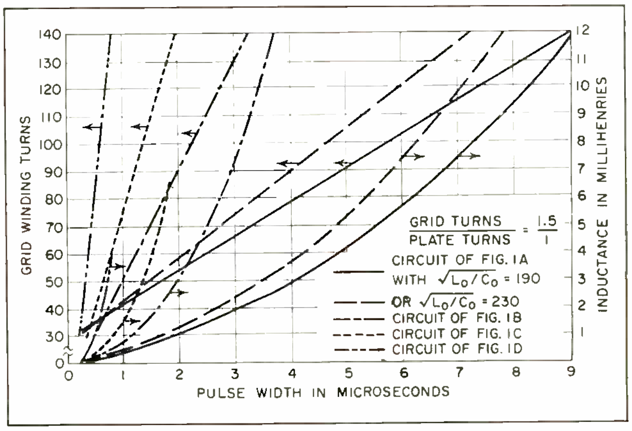


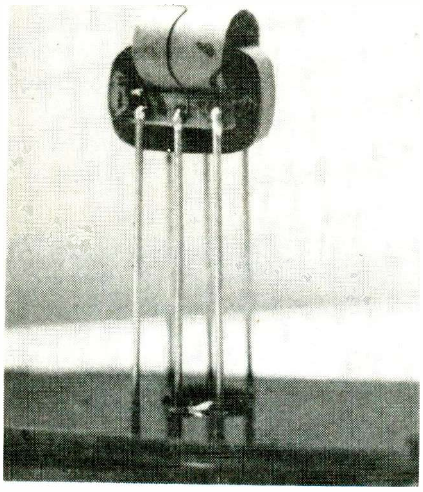
FIG. 3—Pulse width versus grid turns (left ordinate) and L-1 core inductance (right ordinate) are for type 5687 with 500-ohm load. Grid turns to plate turns ratios are 1.5/1

Design data for blocking-oscillator transformers is obtained by using four common circuits with three tube types. Pulse-initiation curves indicate turns ratio for maximum power output of each load conductance. Pulse-width curves show turns level that gives desired pulse width. For other circuits, turns level can be selected where control capacitance value is designated. Transformers designed by this method, entirely upon L-1 core, achieve 1/6 size reduction

For Blocking Oscillators

From the pulse-initiation curves, turns ratios of 1.5 to 1, 1 to 1 and 1 to 1.5 give maximum power output for most load conditions. All transformers have L-1 cores and three windings with the outer winding having the same number of turns as the one closest to the core. Rise time is improved with the middle winding in the plate circuit, the inner in the grid, and load across the outer.

The pulse-width data is obtained using a load of 500 ohms, the optimum turns ratio for the tube in use and the four circuits. When using the circuit of Fig. 1A the control capacitor C_o is adjusted for flat pulse response.



Mechanical construction in shown in closeup of transformer

Reduced size is indicated by comparison with one-cent piece

Pulse Width Curves

Width versus turns on an L-1 core is plotted for each tube and circuit and are shown in Fig. 3, 4 and 5. With these curves, it is possible to select a level of turns that gives a desired pulse width for each of the three tubes in any of the four test circuits. For any other

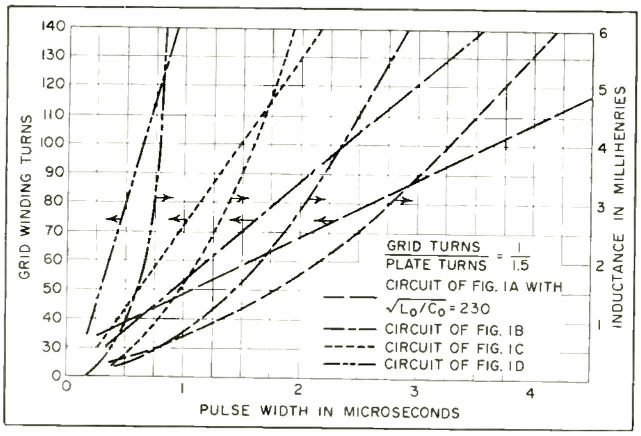


FIG. 4—Pulse width versus grid turns (left ordinate) and L-1 core inductance (right ordinate) for tube-type 5814 WA with 500-ohm load. Grid turns to plate turns ratios are 1/1.5

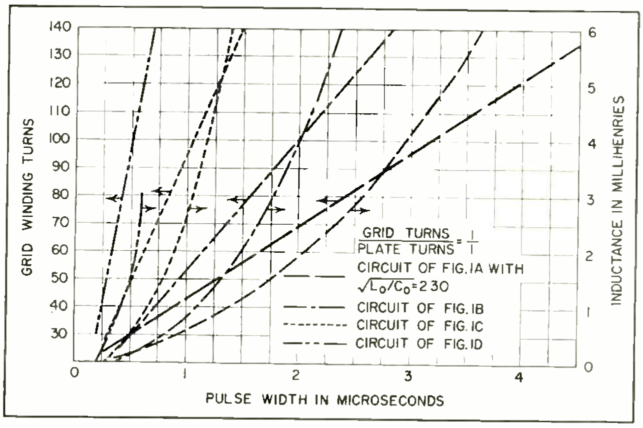


FIG. 5—Pulse width versus grid turns (left ordinate) and L-1 core inductance (right ordinate) for tube-type 5965 with 500-ohm load. Grid turns to plate turns ratios are 1/1

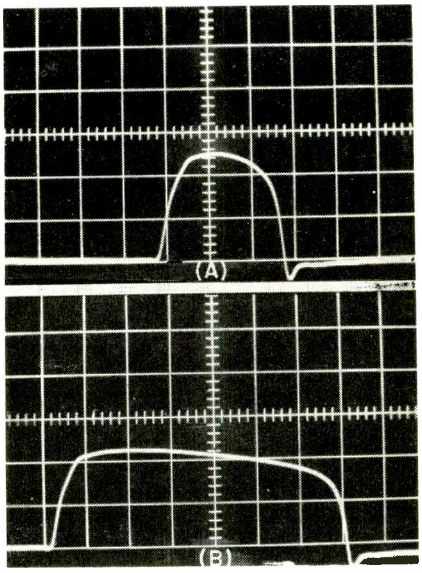
circuit, the turns level can be selected where the control capacitance value is designated.

The L-1 core of 0.002-in. Hipersil suffices over a pulse-width range from 0.5 to 5 μsec under average conditions. Different widths are obtained for different turns levels of the coil. Beyond 5 μsec a large core area is advisable. From 0.1 to 0.5 μsec, the M-3, a 0.001-in. Hipersil core with the same physical dimensions as the L-1 core, should be used.

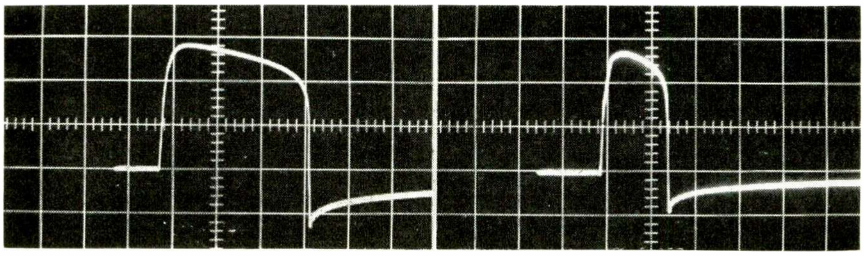
Materials

Class A materials are satisfactory for use up to 125 C. Coil tubes should be made of Kraft paper with a fish-paper liner. Kraft paper should also be used as layer insulation and wrap.

Enameled-wire of sizes 30 to 40 is satisfactory to 125 C. The usual basis for size selection is 25 w/lb although for small-size units 50 w/lb may prove usable. A low cost, simply designed and built winding scheme is sufficient except in extreme cases, for coil design. Margins and layer insulation should be based on a maximum of 25 v/mil creep and 250 v/mil puncture when using Kraft paper. In a similar manner the impedance required determines the layer insulation thickness.



Blocking oscillator pulses for 200-pps (left) and 1,000-pps (right) repetition rates



Pulse shapes are shown for control capacitance values of 0.005μf (A) and 0.32μf (B). Load resistance is 250 ohms and scale is 0.2 sec/division and 50 v/division amplitude

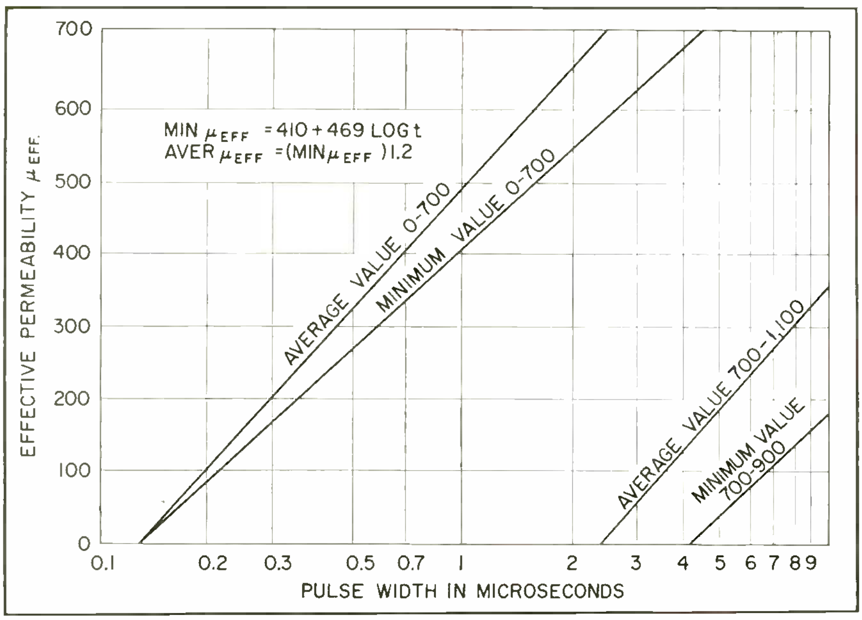


FIG. 6—Effective permeability is plotted as a function of pulse width

Impedance

The impedance $\sqrt{L_o/C_o}$ of a transformer where L_o is leakage inductance and C_o is the distributed capacitance should be made equal to the load impedance for the best pulse shape. This is usually done by adjustment of the thickness of layer insulation.

The pulse permeability curve of Fig. 6, used in conjunction with the formula

$$L_o = \frac{3.19\, N^2\, A\, N_{eff}/100}{L_{FE}}$$

where N_{eff} is effective pulse permeability, L_{FE} is the mean length of magnetic path and A is core gross area, establishes the open circuit inductance for use in calculating the control capacitance value in circuits other than Fig. 1 B, C and D. The average value of effective pulse permeability should be used in all cases.

Pulse Shape

Width of the pulse is determined mainly by the transformer open-circuit inductance and size of the control capacitance. An increase in either one causes a proportional increase in width.

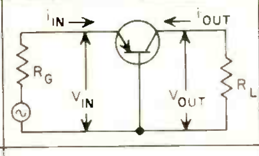
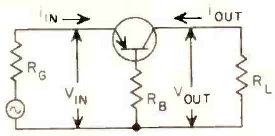
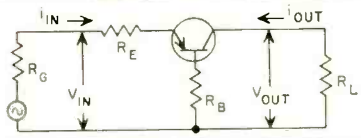
A flat pulse may be obtained from any unit by adjusting the control capacitance until $(L_o/C_o)^{1/2} = 230$ ohms. Since the R_gC_o time constant must be much less than the spacing between pulses to allow the grid voltage to reach the bias point before arrival of the next trigger pulse, this is not always possible. Therefore, for the higher repetition rates some droop can be expected on the pulse top as seen in the wave shape photographs.

Pulse output voltage is directly proportional to the applied voltage or E_{bb}. Operation is usually at the tube manufacturer's recommended value.

The curves presented permit the design of transformers entirely on the L-1 core, thereby achieving a size reduction to approximately 1/6 of previous units. Reasonably flat pulses can now be obtained in any circuit, and an accurate prediction of pulse width made.

Transistor Formulas Use h-Matrix Parameters

COMMON - BASE ARRANGEMENTS

			
VOLTAGE GAIN $\left(\frac{V_{OUT}}{V_{IN}}\right)$	$\frac{-h_f R_L}{h_i + DR_L}$	$\frac{R_L(h_o R_B - h_f)}{h_i + DR_L + R_B(M + h_o R_L)}$	$\frac{R_L(h_o R_B - h_f)}{h_i + DR_L + R_B(M + h_o R_L + h_o R_E) + R_E(1 + h_o R_L)}$
CURRENT GAIN $\left(\frac{i_{OUT}}{i_{IN}}\right)$	$\frac{-h_f}{h_o R_L + 1}$	$\frac{h_o R_B - h_f}{1 + h_o(R_B + R_L)}$	$\frac{h_o R_B - h_f}{1 + h_o(R_B + R_L)}$
INPUT RESISTANCE (R_{IN})	$\frac{h_i + DR_L}{1 + h_o R_L}$	$\frac{h_i + DR_L + R_B(M + h_o R_L)}{1 + h_o(R_B + R_L)}$	$R_E + \frac{h_i + DR_L + R_B(M + h_o R_L)}{1 + h_o(R_B + R_L)}$
OUTPUT RESISTANCE (R_{OUT})	$\frac{h_i + R_G}{D + h_o R_G}$	$\frac{h_i + R_G + R_B(M + h_o R_G)}{D + h_o(R_B + R_G)}$	$\frac{h_i + R_G + R_E + R_B[M + h_o(R_G + R_E)]}{D + h_o(R_B + R_E + R_G)}$
EQUIVALENT h MATRIX	$h_{11} = h_i$ $h_{12} = h_r$ $h_{21} = h_f$ $h_{22} = h_o$	$h_{11} = \frac{h_i + MR_B}{1 + h_o R_B}$ $h_{12} = \frac{h_r + MR_B}{1 + h_o R_B}$ $h_{21} = \frac{h_f - h_o R_B}{1 + h_o R_B}$ $h_{22} = \frac{h_o}{1 + h_o R_B}$	$h_{11} = R_E + \frac{h_i + MR_B}{1 + h_o R_B}$ $h_{12} = \frac{h_r + h_o R_B}{1 + h_o R_B}$ $h_{21} = \frac{h_f - h_o R_B}{1 + h_o R_B}$ $h_{22} = \frac{h_o}{1 + h_o R_B}$

Charts list formulas for small-signal performance of transistor with external resistances in series with one or more of its leads in grounded-base, grounded-emitter and grounded-collector configurations. Formulas have been derived without approximations; simplifications may be made to fit specific situations

By **ALBERT E. HAYES, JR.** Project Manager, Mechanical Division, General Mills, Inc. Minneapolis, Minnesota

THE FORMULAS given here define the performance of a transistor, with external resistances in series with one or more of its leads, in terms of h-matrix parameters.

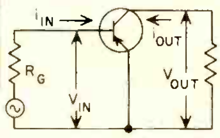
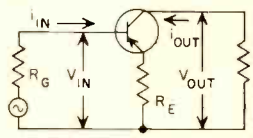
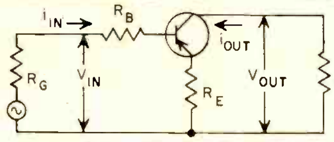
The equations are intended for use in the low-frequency region where the parameters are substantially independent of frequency ($\approx$ 1 per cent of $f_{\alpha co}$). Equations may be used at any frequency provided that the parameters are measured at the frequency of operation, the complex value of each parameter is measured and impedances and admittances are used in place of resistances and conductances.

Common-base small-signal, short-circuit input resistance is designated by h_i, open-circuit reverse-transfer voltage ratio by h_r, short-circuit forward-transfer current ratio by h_f and open-circuit output conductance by h_o. Quantity D is the determinant of the h matrix ($D = h_i h_o - h_f h_r$), and $M = D + h_f - h_r + 1$.

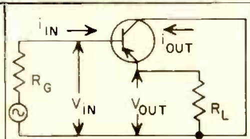
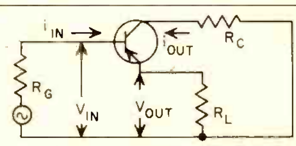
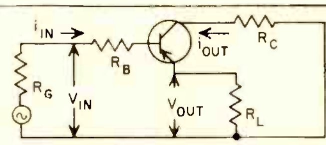
(Continued on page 82)

Transistor Formulas Use h-Matrix Parameters (continued from p 81)

COMMON-EMITTER ARRANGEMENTS

			
VOLTAGE GAIN $\left(\frac{V_{OUT}}{V_{IN}}\right)$	$\frac{(D+h_f)R_L}{h_i+DR_L}$	$\frac{(D+h_f+h_oR_E)R_L}{h_i+DR_L+R_E(1+h_oR_L)}$	$\frac{(D+h_f+h_oR_E)R_L}{h_i+DR_L+R_E[1+h_o(R_B+R_L)]+R_B(M+h_oR_L)}$
CURRENT GAIN $\left(\frac{i_{OUT}}{i_{IN}}\right)$	$\frac{D+h_f}{h_oR_L+M}$	$\frac{D+h_f+h_oR_E}{h_o(R_E+R_L)+M}$	$\frac{D+h_f+h_oR_E}{h_o(R_E+R_L)+M}$
INPUT RESISTANCE (R_{IN})	$\frac{DR_L+h_i}{h_oR_L+M}$	$\frac{DR_L+h_i+R_E(1+h_oR_L)}{h_o(R_E+R_L)+M}$	$R_B+\frac{DR_L+h_i+R_E(1+h_oR_L)}{h_o(R_E+R_L)+M}$
OUTPUT RESISTANCE (R_{OUT})	$\frac{h_i+MR_G}{D+h_oR_G}$	$\frac{h_i+MR_G+R_E(1+h_oR_G)}{D+h_o(R_E+R_G)}$	$\frac{h_i+M(R_B+R_G)+R_E[1+h_o(R_B+R_G)]}{D+h_o(R_B+R_E+R_G)}$
EQUIVALENT h MATRIX	$h_{11}=\frac{h_i}{M}$ $h_{12}=\frac{D-h_r}{M}$ $h_{21}=\frac{-(D+h_f)}{M}$ $h_{22}=\frac{h_o}{M}$	$h_{11}=\frac{h_i+R_E}{M+h_oR_E}$ $h_{12}=\frac{D-h_r+h_oR_E}{M+h_oR_E}$ $h_{21}=\frac{-(D+h_f+h_oR_E)}{M+h_oR_E}$ $h_{22}=\frac{h_o}{M+h_oR_E}$	$h_{11}=R_B+\frac{h_i+R_E}{M+h_oR_E}$ $h_{12}=\frac{D-h_r+h_oR_E}{M+h_oR_E}$ $h_{21}=\frac{-(D+h_f+h_oR_E)}{M+h_oR_E}$ $h_{22}=\frac{h_o}{M+h_oR_E}$

COMMON-COLLECTOR ARRANGEMENTS

			
VOLTAGE GAIN $\left(\frac{V_{OUT}}{V_{IN}}\right)$	$\frac{(1-h_r)R_L}{h_i+R_L}$	$\frac{(1-h_r+h_oR_C)R_L}{h_i+R_L(1+h_oR_C)+DR_C}$	$\frac{(1-h_r+h_oR_C)R_L}{h_i+DR_C+R_L[1+h_o(R_B+R_C)]+R_B(M+h_oR_C)}$
CURRENT GAIN $\left(\frac{i_{OUT}}{i_{IN}}\right)$	$\frac{1-h_r}{h_oR_L+M}$	$\frac{1-h_r+h_oR_C}{h_o(R_C+R_L)+M}$	$\frac{1-h_r+h_oR_C}{h_o(R_C+R_L)+M}$
INPUT RESISTANCE (R_{IN})	$\frac{h_i+R_L}{h_oR_L+M}$	$\frac{h_i+R_L+R_C(D+h_oR_L)}{h_o(R_C+R_L)+M}$	$R_B+\frac{h_i+R_L+R_C(D+h_oR_L)}{h_o(R_C+R_L)+M}$
OUTPUT RESISTANCE (R_{OUT})	$\frac{h_i+MR_G}{1+h_oR_G}$	$\frac{h_i+MR_G+R_C(D+h_oR_G)}{1+h_o(R_C+R_G)}$	$\frac{h_i+(M+h_oR_C)(R_B+R_G)+DR_C}{1+h_o(R_B+R_C+R_G)}$
EQUIVALENT h MATRIX	$h_{11}=\frac{h_i}{M}$ $h_{12}=\frac{1+h_f}{M}$ $h_{21}=\frac{h_r-1}{M}$ $h_{22}=\frac{h_o}{M}$	$h_{11}=\frac{h_i+DR_C}{M+h_oR_C}$ $h_{12}=\frac{1+h_f+h_oR_C}{M+h_oR_C}$ $h_{21}=\frac{h_r-1-h_oR_C}{M+h_oR_C}$ $h_{22}=\frac{h_o}{M+h_oR_C}$	$h_{11}=R_B+\frac{h_i+DR_C}{M+h_oR_C}$ $h_{12}=\frac{1+h_f+h_oR_C}{M+h_oR_C}$ $h_{21}=\frac{h_r-1-h_oR_C}{M+h_oR_C}$ $h_{22}=\frac{h_o}{M+h_oR_C}$

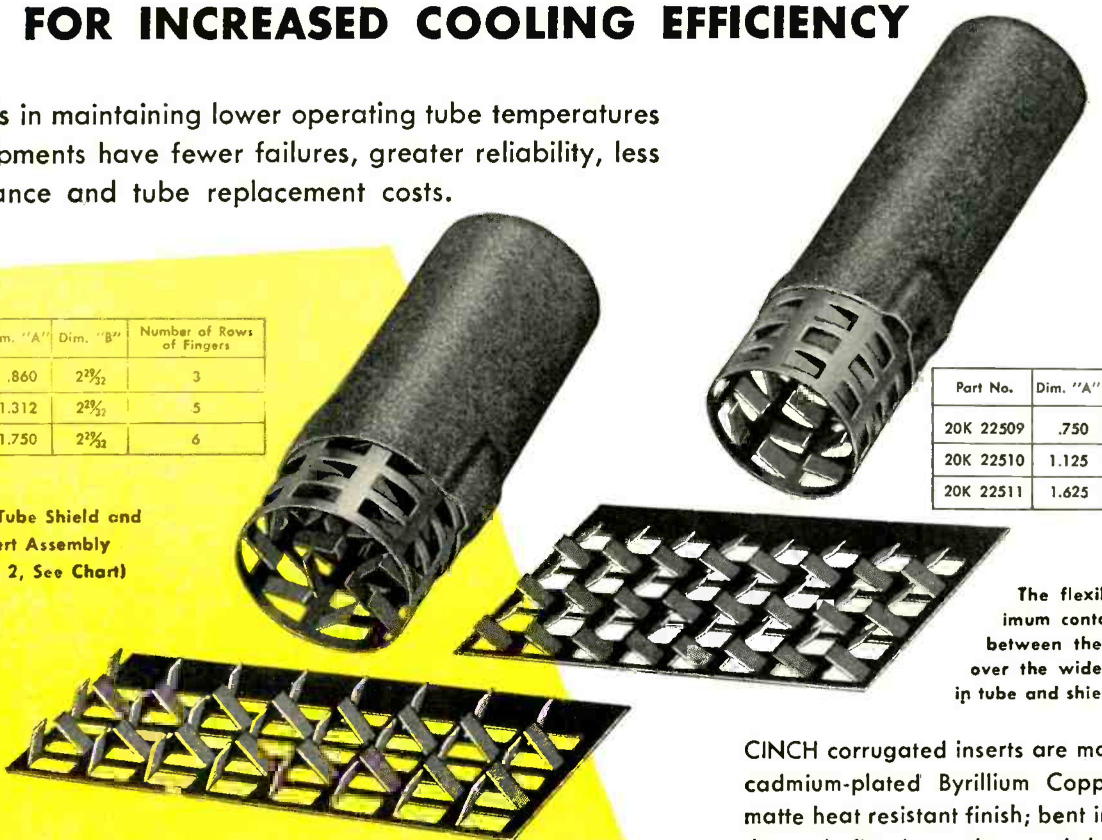
NEW CINCH-JAN

HEAT DISSIPATING

SHIELD INSERT

FOR INCREASED COOLING EFFICIENCY

. . . . aids in maintaining lower operating tube temperatures . . . equipments have fewer failures, greater reliability, less maintenance and tube replacement costs.



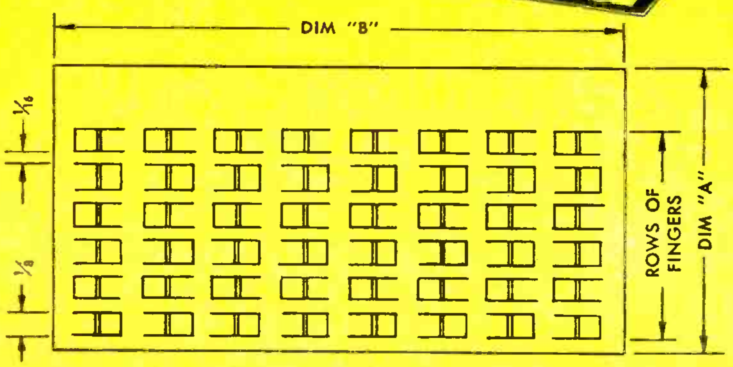
Miniature Tube Shield and Insert Assembly (Type 1, See Chart)

Part No.	Dim. "A"	Dim. "B"	Number of Rows of Fingers
20K 22509	.750	$2\frac{1}{2}$	3
20K 22510	1.125	$2\frac{1}{2}$	4
20K 22511	1.625	$2\frac{1}{2}$	6

Noval Tube Shield and Insert Assembly (Type 2, See Chart)

Part No.	Dim. "A"	Dim. "B"	Number of Rows of Fingers
20K 22512	.860	$2\frac{29}{32}$	3
20K 22513	1.312	$2\frac{29}{32}$	5
20K 22514	1.750	$2\frac{29}{32}$	6

The flexible fingers insure maximum contact of the cooling insert between the tube and outer shield over the wide tolerances encountered in tube and shield assemblies.

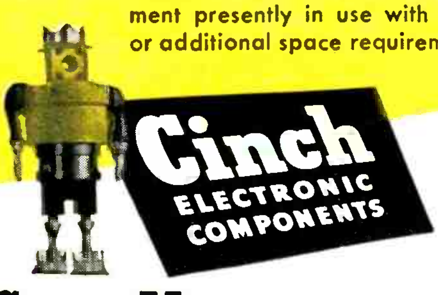


CINCH corrugated inserts are made from 0.003 inch cadmium-plated Byrillium Copperstock with black matte heat resistant finish; bent into a circular shape, the ends fitted together, and then inserted into the proper shield. The insert makes contact with the circumference of the glass bulb and the shield on the other side, conducting the heat to the shield with a greater radiating surface.

Meet requirements of MIL Standard 242A and MIL-S-19786A (Navy)

These inserts may be adapted to operating equipment presently in use with no chassis modification or additional space requirements.

Shield & Insert No.	Type	Tube Shield No.	Shield Insert No.	Shield Length	JAN No.
13A 22699	1	13A 963	20K 22509	$1\frac{3}{8}$	TS 102U01
13A 22700	1	13A 964	20K 22510	$1\frac{3}{4}$	TS 102U02
13A 22701	1	13A 965	20K 22511	$2\frac{1}{4}$	TS 102U03
13B 22702	2	13B 17873-1	20K 22512	$1\frac{1}{2}$	TS 103U01
13B 22703	2	13B 17874-1	20K 22513	$1\frac{15}{16}$	TS 103U02
13B 22704	2	13B 17875-1	20K 22514	$2\frac{3}{8}$	TS 103U03



Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, LaPuente, California and St. Louis, Missouri.

CINCH MANUFACTURING CORPORATION

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Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

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X-Rays Control Strip Mill

Beta bombardment of a target produces x-rays to control metal thickness from a strip mill controlled by a three-zone servo system

X-RAYS emitted from a target bombarded by beta rays are used to control the thickness of metal strips produced by a rolling mill. The system, developed by the Baldwin Instrument Co. Ltd., England, also uses a special antihunting servo system.

The thicknesses involved in this application exceed the measuring capacity of present nucleonic thickness gages. And x-ray tubes were eliminated because they require high voltages, are costly, fragile and bulky.

An assembly containing a strontium 90 radio active source, the metal target and shutter and a detector assembly are mounted on opposite sides of the strip. X-ray emission from the target is directed at the detector by the solenoid-operated shutter.

Radiation penetrating the strip strikes a sodium-iodide crystal that scintillates causing visible light proportional to radiation intensity. A multiplier photo tube is used to generate an output proportional to light intensity and hence to plate thickness.

The system is self monitoring against a standard. A microswitch is mounted on the ingoing side of the mill and is tripped when the tail of a strip passes it. This causes the measuring hand to withdraw and the shutter to rotate a standard sample between the source and the detector.

A highly stable d-c amplifier circuit is used with a very large amount of negative feedback. If the amplifier gets a deviation signal, amplifier output voltage is fed to a servo motor through a relay-discriminator circuit. This motor drives the potentiometer directly connected to the multiplier photo tube until a balance is achieved and the amplifier output zeroes on the standard.

When producing strip of the correct thickness, the system is balanced and there is no output to the amplifier. When the strip is not the correct thickness, the amplifier receives a signal that is proportional to deviation. The amplifier output operates the screw down motors through relays.

The system recognizes three zones of deviation and responds with either an intermittent or continuous correcting action.

In a dead zone accepting a thickness deviation of plus or minus 0.0003 inch, it takes no action. When the deviation lies between plus or minus 0.0005 inch, the system sends 0.25-second pulses at two second intervals to the screwdown motor via the relays. For deviations in excess of this thickness the motors are operated continuously.

This control action is claimed to have better antihunting characteristics than the normal systems in which correction is continuously proportional to deviation from the dead zone.

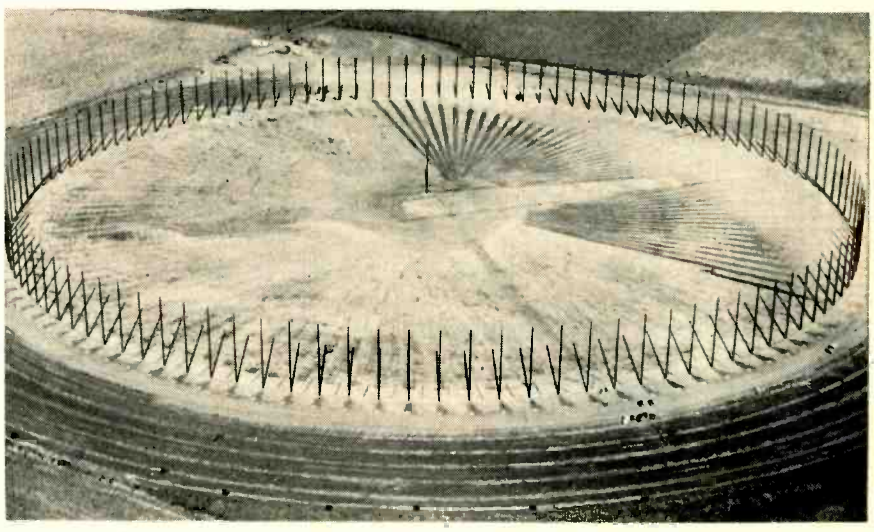
Direction Finding Gets Push

RADIO DIRECTION finding will be studied at the University of Illinois by what is claimed to be the free world's largest direction finder. Primary object of the experiments is to determine more accurately the deflection of radio signals caused by the ionosphere.

The finder was designed jointly by the University of Illinois and Federal Telecommunications Laboratories under Navy Bureau of Ships sponsorship.

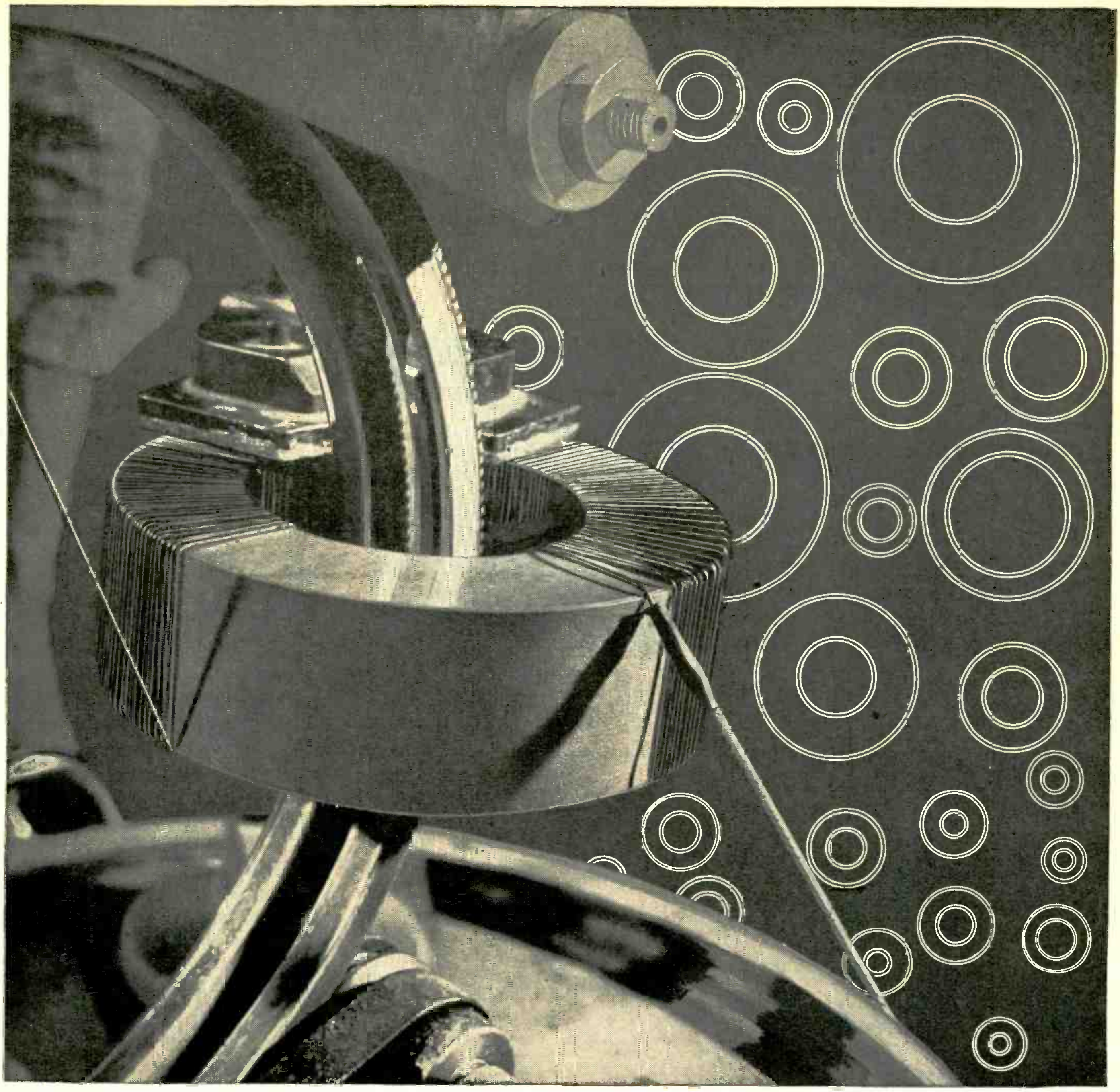
A circle of 120 poles each 65 feet high have been erected on a 40-acre site. The poles support a screen of 1,200 vertical wires two feet apart and 65 feet high.

Outside the screen will be 120 vertical antennas, each 15 feet high and set on concrete pedestals in a 955-foot circle. A coaxial cable will connect each to a laboratory building.



One-hundred twenty 65-foot poles will support a screen of 1,200 vertical wires as part of direction-finding antenna system

Under and outside the screen, a ground mat of interlaced wires has



Here's how magnetic amplifier design will be affected by tape wound core standardization

If you design and manufacture magnetic amplifiers, you'll welcome news that standard sizes for tape wound cores have been proposed by the A.I.E.E.* You are going to benefit from a high in consistency of core performance, brought about by our being able to concentrate on your most important sizes. *Here's how . . .*

Magnetics, Inc. is now stocking all of the proposed standard core sizes in both aluminum and phenolic core boxes for immediate delivery. Consistency of core performance is increased because each size is made in large lots taken from the same alloy batch and dry hydrogen anneal. They all bear our exclusive Performance-Guarantee.

We shall be happy to send size, construction and magnetic material data upon request. Please write to *Magnetics, Inc., Dept. E-44, Butler, Pa.*

MAGNETICS inc.

**Paper 57-206, Proposed Size Standards for Toroidal Magnetic Tape Wound Cores. Report of the Magnetic Amplifiers Material Sub-Committee, at the 1957 Winter General Meeting, A.I.E.E.*

CIRCLE 41 READERS SERVICE CARD

been buried to a diameter of 1,300 feet.

The array is an enlargement of the Wullenweber radio direction finder developed by the Germans during World War II. Construction is expected to be completed by spring.

The project is aimed at improving direction finding techniques, including equipment design and operation.

Fast Cable Impedance Tests

By JOHN H. MENNIE
Vice President
Boonton Electronics Corp.
Boonton, N. J.

CHARACTERISTIC impedance of either coaxial or balanced transmission line is important from the manufacturers point of view for quality control. It is also important to the user to know the variation from nominal for individual lengths of cable.

Reworking standard equations for the relationship between characteristic impedance, total capacitance and resonant frequency permits simplified measurement techniques for any low-loss transmission line. Conventional laboratory equipment can be used.

The ensuing description will be limted to low-loss polyethylene, teflon or air dielectric cable.

From standard relationships, it can be demonstrated that

$$Z_o = 1/FC$$

where Z_o is characteristic impedance, F is frequency in cycles per second at which sample cable is one wavelength and C is total capacitance in farads.

For practical purposes, the equation can be rewritten in the form

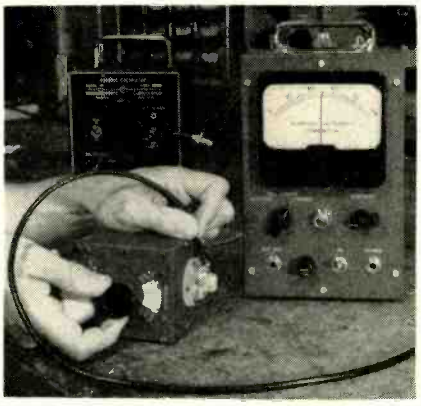
$$Z_o = 10^6/fc$$

where f is frequency in megacycles at which sample cable is one wavelength and c is total capacitance in micromicrofarads.

This equation offers two prime advantages over the conventional method, as required in MIL-C-17C: It does not involve measuring cable length or percent velocity of propagation.

Measurement of Frequency

The frequency at which the test sample is one wavelength may be determined by either a signal-generator or grid-dip meter technique. The signal generator method[1] requires a variable frequency generator having a 50-ohm internal source impedance and a 50-ohm terminating impedance at the end of its output cable. An open-circuited cable sample in parallel with a sensitive broadband r-f millivoltmeter is connected across the 50-ohm output termination. Minimum voltage points occur at frequencies representing odd multiples of the frequency at which the test sample is one quarter wavelength.



Center conductor is held about ¼ inch from coil terminal in grid-dip meter method of measuring characteristics impedance of cable

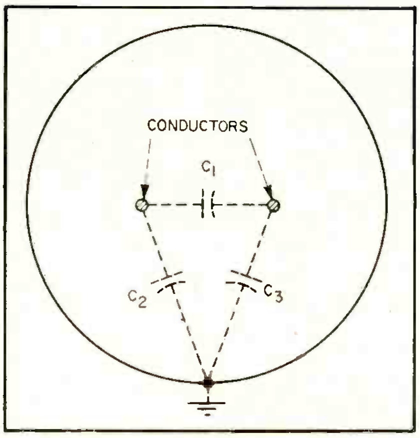


FIG. 1—Equivalent capacitance network for balanced transmission line

The exact number (N) of quarter wavelengths may be readily determined by dividing half the difference in megacycles between two successive resonant points into the resonant frequency (f_r) at which the characteristic impedance is to be measured. The effective full wave frequency (f) can then be computed as $(4 f_r)/N$.

This technique is generally useful for testing lengths of cable from 5 to 100 ft at frequencies from one to 150 megacycles.

For testing 5 in. to 5 ft, lengths of cable the grid-dip meter technique has been found to be the most satisfactory for determining half-wave resonance points without introducing connection errors. In this case N becomes an even number (2, 4, 6, 8). Resonance points must be detected by loose capacitive coupling between one side of the grid-dip meter coil and the center conductor of the cable under test, which is open at both ends. The center cable conductor is held about ¼-inch from coil terminal. Inductive coupling is not recommended for testing short lengths of coaxial cable as the coupling loop will introduce an error of a few percent in resonant frequency. For precision work it is advisable to calibrate the signal generator or grid-dip meter with a suitable frequency standard.

Slightly different techniques are necessary for measuring the full wavelength frequency (f) on balanced transmission lines of either the shielded or unshielded variety. Here again the grid-dip meter has been found ideal for detecting resonance modes without introducing connection errors.

Because it is not possible to couple to a balanced line by the capacitance technique, the inductive coupling method is used. A straight shorting wire between center conductors will serve as a pick-up loop. Because inductance of a balanced line is much higher than that of a coaxial line of the same length, the resonance frequency error introduced by this short pick-up loop has been found to be negligible for balanced lines over 20 inches.

Measurement of Cable Capacitance

The capacitance of a coaxial cable sample should be measured on a precision capacitance bridge at some low frequency, usually from one to 100 kc. The frequency is unimportant as long as the length

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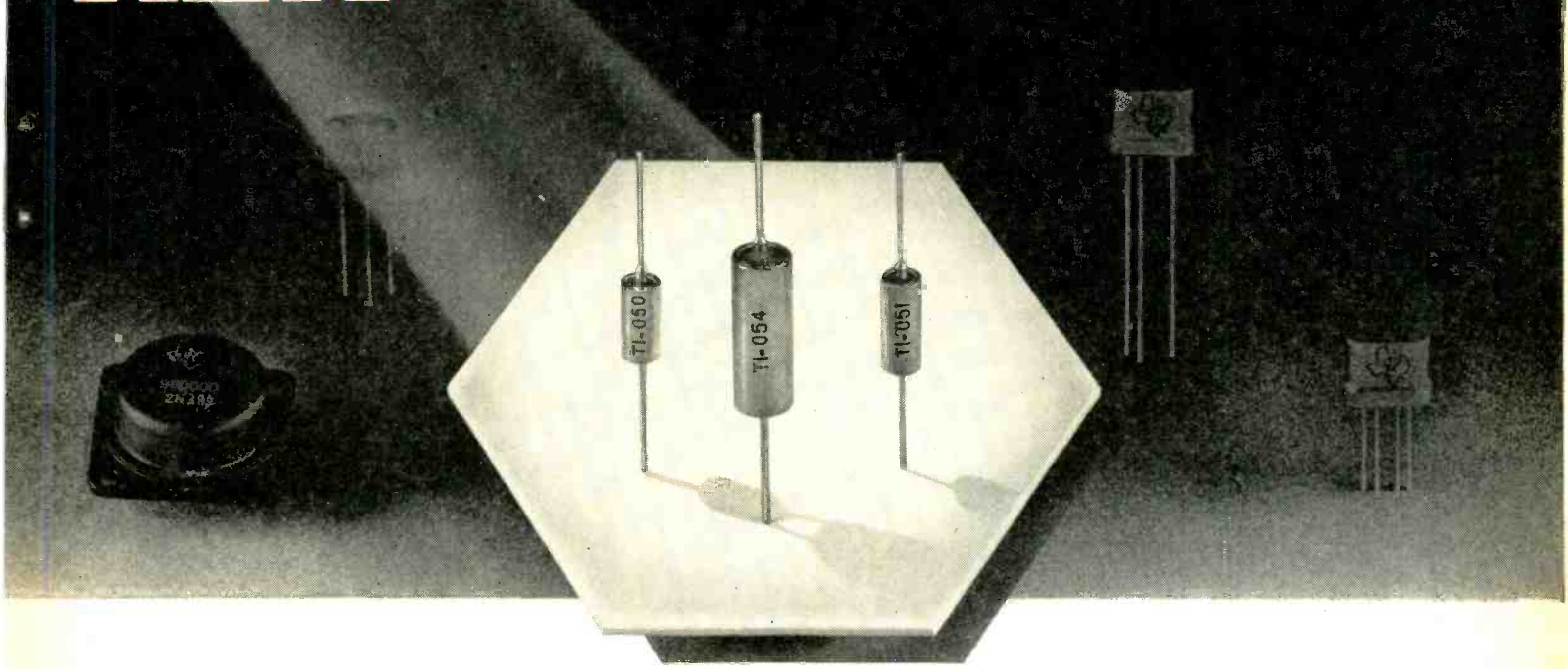

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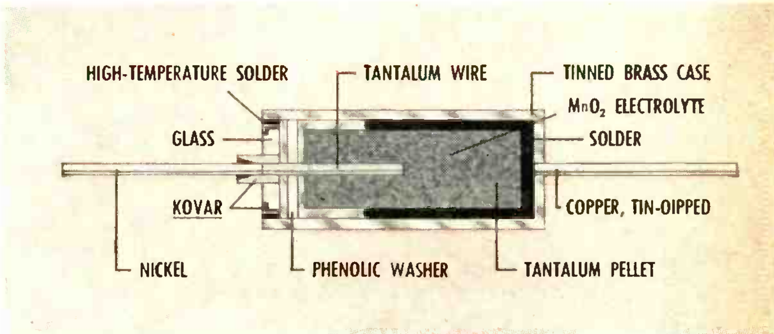

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33	15	10	8
47	22	15	25
60	33	35	
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of cable under test is less than 1/40 wavelength.

Extra precautions must be taken to avoid errors resulting from improper technique when measuring small capacitance values. For example, if a Tee connector is used as a means for connecting the cable sample to the signal generator test set-up, the capacitance of one leg of the Tee should be added to the measured capacitance of the cable sample. This capacitance may be assumed to be one third of the total capacitance of the Tee connector.

The effective capacitance (c) of a sample length of balanced cable is slightly more difficult to measure than that of coaxial cable. Figure 1 shows the equivalent capacitance network for balanced cable where C is the direct capacitance between conductors, and C_2 and C_3 represent capacitance to ground or shield, as the case may be. Assuming that C_2 and C_3 are approximately equal, the effective cable capacitance becomes $c = C_1 + (C_2 + C_3)/4$.

The sum of C_2 and C_3 can be measured by connecting two center conductors together and measuring total capacitance to ground with a precision capacitance bridge.

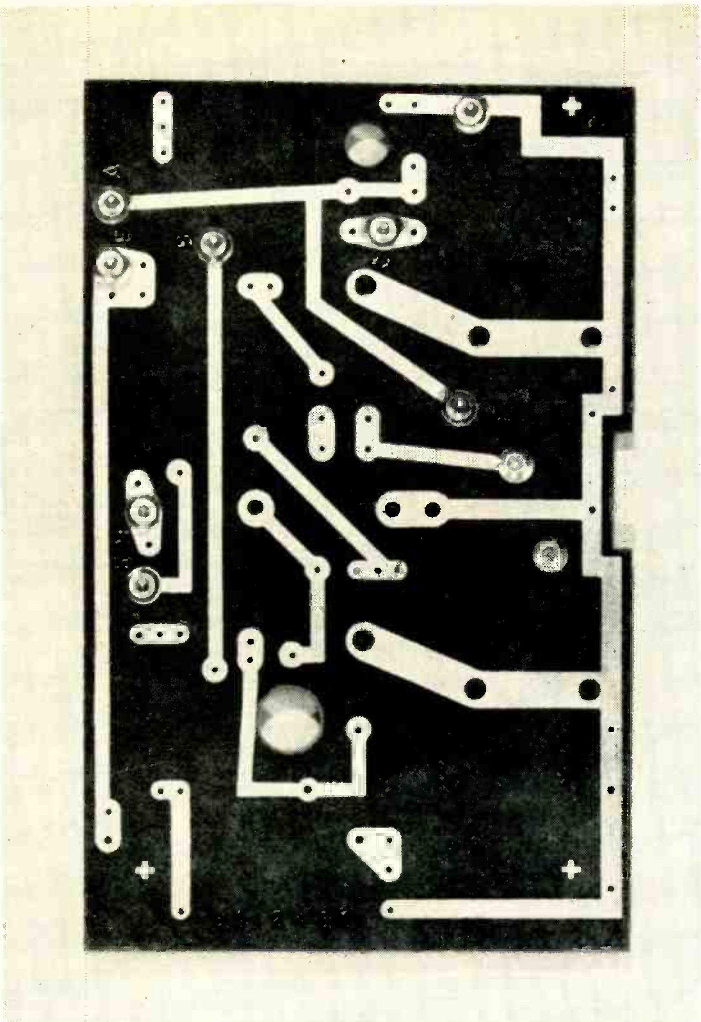
The direct interconductor capacitance C_1 can be measured in one operation by means of a three-terminal capacitance bridge.

Another method for measuring effective capacitance of balanced cable is outlined in MIL-C-17B, paragraph 4, 6, 10. This method involves three separate grounded capacitance measurements, each requiring a high degree of accuracy. Final capacitance determination may be of questionable accuracy however, as it is computed from the difference between measured values.

When measuring capacitance of unshielded twin-line or twisted-pair cable by any of these methods, it is essential to provide a good ground connection to the instrument used for making the test.

Test Results and Conclusions

Test data was compiled using various lengths of RG-58/U coaxial cable from the same reel. Measurements were made at a number of frequencies from 2 to 1,000 megacycles. Close agreement was found between measurements made on a



Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed-circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

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*Du Pont trademark for its tetrafluoroethylene resin.

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TYPICAL Di-Clad PROPERTY VALUES

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BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

short length of cable at uhf frequencies by the grid-dip meter technique and measurements made using the signal-generator method on long lengths at frequencies from 50 to 150 megacycles.

These results suggest that except when it is necessary to know Z_o at low frequencies, measurements of characteristic impedance on low-loss coaxial cable be made at frequencies above 300 megacycles using sample lengths from 2 to 5 feet. If it is required to measure longer lengths of cable, the signal generator-millivoltmeter technique is recommended using test frequencies below 100 megacycles.

To measure short lengths (less than 2 feet) of coaxial cable, the accuracy and technique of capacitance measurement become limiting factors. Characteristic impedance measurements on 300-ohm twin line should be made on lines sufficiently long to permit good capacitance accuracy and short enough to facilitate suspension of the cable in mid-air during the test. Resonances may be detected at any convenient frequency (depending on length) from 2 to 1,000 megacycles by the grid-dip meter technique.

References

(1) *General Radio Experimenter*, August, 1957.

Tube Makes Tv of PPI

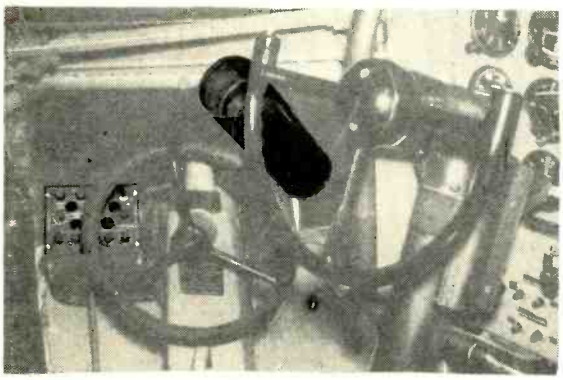
A special tube is making it possible to broadcast a television picture of a radar PPI presentation covering an area 100 km radius around Brussels National Airport. The radial trace is converted by the image-transforming tube into a 625-line tv picture to be broadcast to control centers and even to aircraft.

For Jet Fleet

Qantas is the latest international airline to order Edo Loran. The new Edo long-range navigation equipment, already thoroughly tested by Qantas in a Super-G Constellation, will be installed as original equipment when the airline takes delivery of the Boeing 707 jet transports it has on order.

As a result of extensive operational appraisal across both the Pacific and Atlantic Oceans, Edo's pilot-operated Loran was recently selected by Pan American World Airways for its jet transports. Other international carriers are at present evaluating the equipment.

Airline pilots and technicians alike endorse Edo Loran for speed and ease of operation, accuracy, and reliability in service. Precise fixes are obtained by the pilot in a matter of seconds from the direct-reading cockpit display. Weight of entire unit is only 29 pounds. Design and performance of this new Edo Loran, plus the acknowledged reliability of the Loran System, make this the logical choice as basic long-range navigation equipment for modern airliners.



Installation of Edo Loran in Pan American Boeing Stratocruiser shows compact design and convenient mounting for pilot operation. 3/4 ATR receiver unit is remotely installed.

Technical brochure # 104 available on request.

EDO Corporation

College Point, Long Island, New York

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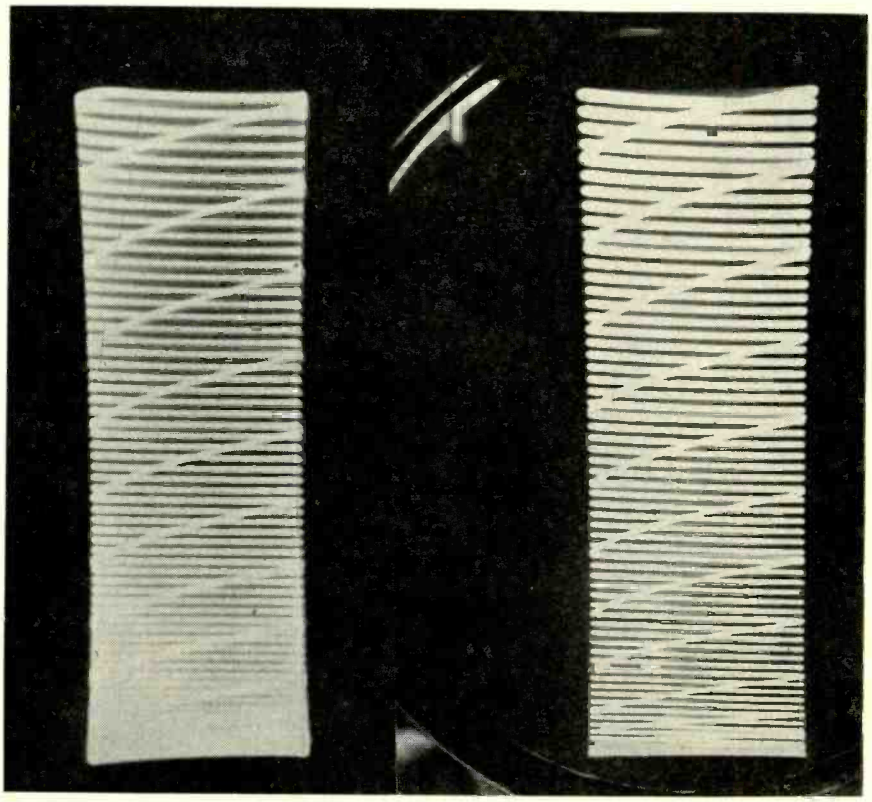
AIEE Sets Magnetic Component Standards

STANDARD TEST methods of magnetic core characteristics proposed by the AIEE at it's Winter General Meeting have at last provided the industry with building blocks for a handbook or catalog. Practical application of magnetic components has been hampered because the design engineer has not had specifications available to apply to his particular problem. Now that standard core sizes and test methods are established the design engineer will be able to choose a tape wound core as he would a vacuum tube, resistor or any catalog component with published characteristics.

Design engineers working on a control system in the past used up precious time, designing a reactor that would do the job. In many cases the designer was forced into being concerned with what the reactor was to be, rather than with the reactor's function in the overall system. The situation is similar to an engineer determining dielectric specifications of a capacitor he wishes to use in a circuit.

When at last the design parameters were set, the core manufacturer was requested to "make it". And here's where two serious problems cropped up; high nickel steel alloys vary from batch to batch and test methods vary almost to a point of frustration. Standardization established by the AIEE should release the systems engineers from these laborous problems.

Merit of standardization was proved in just one year at Magnetics, Inc. where it was anticipated that only 30 percent of tape wound core business would involve standard sizes . . . year-end figures show that 67 percent were standard sizes



High resolution of thin-screen transparent phosphor tube is shown on right. At left is the comparatively fuzzy test pattern of conventional phosphor 5 in. cathode ray tube

Transparent Phosphors Improve CRT

A TRANSPARENT PHOSPHOR developed by the General Electric Research Laboratory, Schenectady, N. Y. greatly improves practically all aspects of cathode ray tube display. Background illumination, from either ambient light or the electron spot itself, does not effect the display on a transparent screen. On a conventional CRT phosphor screen the desired display must be produced on top of the background light limiting contrast and resolution.

Resolution and Ambient Light

Because of the thin, non-scattering nature of the transparent phosphor screen, there is a theoretical resolution of about 10,000 lines per inch. Whereas a standard phosphor screen, with optimum design and operating conditions, permits resolution in the order of 500 lines per in. Since transparent phosphors are transparent by definition, displays can be made under conditions of extremely high ambient lighting. The normally diffuse reflecting surface of a standard phosphor has been eliminated so incident light is not reflected. Instead, the incident light is trapped inside the transparent phosphor tube, resulting in excellent contrast.

Burn-Resistance

Conventional phosphors dissipate heat from the high voltage electron beam in each individual crystal. Excessive heat dissipation produces burning of the phosphor, the screen blackens and tube usefulness is destroyed. With transparent phosphors there is intimate contact with the glass face plate of the tube. This permits heat dissipation into the glass itself, giving more light output without screen degradation. Fifty to five-hundred times more beam current can be used safely without deteriorating the phosphors.

Multi-Color Display

By applying separate layers of transparent phosphors to a tube face blue and yellow color changes

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are produced. Changing the operating voltage of the cathode ray beam controls the penetration of electrons in the phosphor layers. Color is determined by the depth of penetration. A possible application for Penetron multi-color tubes might be in the control of flight patterns around an airport. A radar system could assign the color blue to landing planes and yellow to planes taking off. Military applications are

Transparent phosphor crystals are grown on the cathode-ray-tube face plate

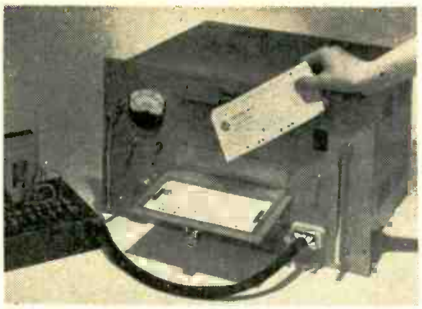
classified, but the possibilities are obvious and highly significant.

The Industrial and Military Section of General Electric is prepared to quote on high resolution cathode ray tubes and is actively engaged in marketing such tubes. Cost and delivery date will depend on glass envelope requirements, complexity of cathode ray gun, and phosphor characteristics (color, persistence, brightness).

Component Testing With Punched Cards

INCOMING inspection of transformers, relays, resistors, transistors, diodes, capacitors, and similar items is performed automatically by a Component Tester. The tester, which makes a complete series of tests according to values indicated by a punched card, can be instantly changed-over to the next type of component.

Programming the instrument, developed by California Technical Industries, 1445 Old County Road, Belmont, Calif. requires only a



Punch-card tester automatically inspects components and identifies the type of fault

business-machine type of card and an ordinary hand punch. A single hole punched in the "Transformer" section, for example, schedules tests for primary impedance, winding ratio, and winding polarity. Several more holes specify the values and tolerances for the particular transformer to be tested. Typical test series includes chokes—inductance at rated d-c current, and resistance; transistors—cut-off current, and gain with specified bias and input currents; relays—pull-in voltage, coil resistance, and contact operation and resistance.

Tests are made on a go/no-go basis with precision bridges used to make the measurements. For each component, the tester either indicates the type of fault that has been found or signifies "Complete" at the end of the test series. The Component Tester is supplied in a cabinet suitable for both rack mounting and bench use. Physical dimensions are $10\frac{1}{2} \times 19$ in. front panel, 21 inches deep.

High-Heat Resistant Laminates For Missiles

PLASTIC LAMINATES, specially designed for missile applications retain their mechanical strength after exposure to operating temperatures as high as 3,500 F. The basic raw material used in the laminate developed by Continental-Diamond Fibre Corp., Newark, Delaware is felted asbestos made from extra-long-staple nonferrous asbestos fiber that has been impregnated with a heat-resistant phenolic resin or varnish. Molded tubes, rods, and parts use the same kind of heat-resistant phenolic resin combined with suitable types of asbestos adaptable to a molding operation.

Fabrication

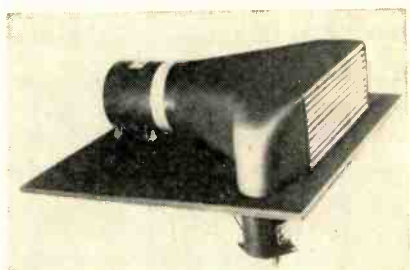
The high-heat resistant materials can be fabricated by conventional methods, including drilling, milling, tapping, sawing, countersinking and counterboring, threading on automatic screw machines, and many other machine-tool operations. The laminates have been cold-punched up to $\frac{1}{8}$ in. Using conventional punching techniques. Electrical insulation properties compare with electrical grades of conventional high pressure laminates.

Their dry properties are retained after two hours immersion in boiling water, or 30 days immersion in water at room conditions.

For missile parts, these CDF asbestos-phenolic products show promise because they retain their high modulus of elasticity, and dimensional stability, after exposure to elevated temperatures for short periods.

Cooling Unit is Part Of Electronic Package

A COOLING UNIT with a net cooling capacity of 1.5 kw at 50,000 feet is packaged as an integral part of the airborne electronic equipment it cools. It is mounted on a lightweight, 20 x 24 in. honeycomb base which is part of the container that holds electronic equipment sealed in a gaseous environment at a constant pressure of 20 psia. Two fans



Cooling unit circulates pressurized sulfur hexafluoride over electronic circuit

and a heat exchanger complete the cooling unit developed by The Garrett Corp., Los Angeles, Calif.

One fan circulates non-toxic sulfur hexafluoride (SK_6) through the heat exchanger and over the electronic equipment within the pressurized container. The other fan draws cooling ambient air through the heat exchanger crosswise to the flow direction of the gas, lowering the gas temperature to desired limits.

The SF_6 which pressurizes and cools the electronic equipment has dielectric strength of 390 v per mil for uniform fields of 60 cycles to 16 mc. Fans are five inches and two inches in diameter and powered by 400 cycle, 3 phase, AC motors running at 22,500 rpm.

Wool Wax Better Capacitor Impregnant

AUSTRALIAN RESEARCH work seems to indicate that wool wax is a better impregnant than petroleum jelly for paper capacitors. Refined wool wax has a dielectric constant of 3.2 compared with a value of only 2.1 for petroleum jelly. Wool wax impregnant gives 10 to 20 percent more capacitance than petroleum jelly, has good insulation resistance and dielectric breakdown strength and a fairly low dielectric loss.

The Australian research is conducted by the Division of Electrotechnology, Commonwealth Scientific and Industrial Research.

P-N Junction As Capacitor

PRACTICAL application of a long-known principle is making another new component available to the electronics industry. Called the Varicap, the device, developed by Pacific Semiconductor, is a voltage-sensitive variable capacitor.

It has been known that the capacitance of a *pn* junction changes when the voltage across it is varied. The new component uses this principle to get changes in capacitance with changes in bias voltage.

Capacitances range from 20 to 56 $\mu\mu f$ for different types. Capacitance can be varied from less than 2/3 to more than twice these values by varying bias.

Jet Spray Automates Transistor Etching Cycle

By MANFRED DOSER Semiconductor Products Dept. General Electric Co. Syracuse, N. Y.

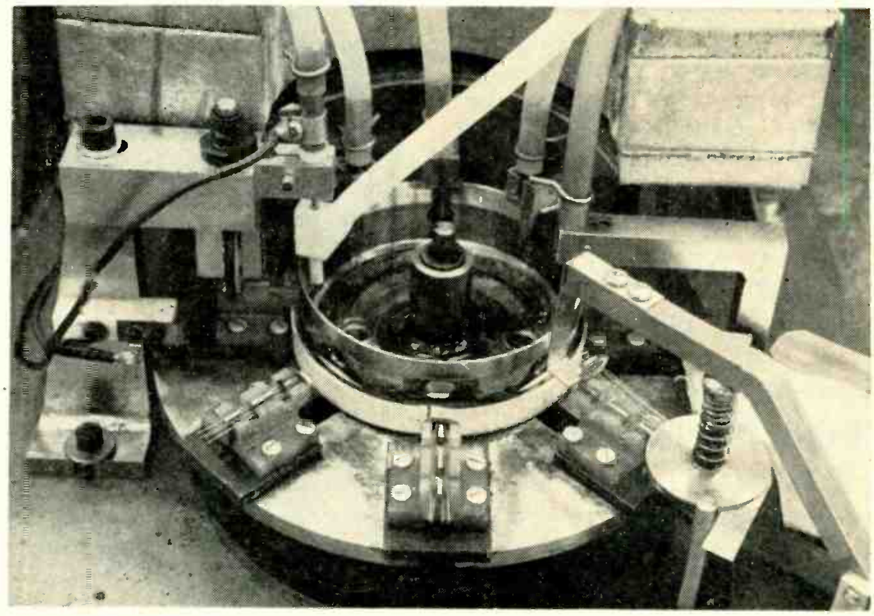
AUTOMATING TRANSISTOR etching cycles has increased the number of transistors etched and rinsed by one operator from 2,000 per day to 720 per hour, helping meet demands for increased production and reduced costs.

A jet etch was chosen in preference to a dip etch. A jet continuously introduces new etching solution, removes the hydrogen bubbles formed during etching, reducing overvoltage and removes the etch solution from around the base region more readily.

The first scheme tried (Fig. 1) proved unsatisfactory. It wet the shorting bar. The bar carried the current, causing little etching of the pellet (*npn* triode transistor).

An air jet incorporated in the nozzle (Fig. 2) restricted the etch flow to the germanium bar. No wet back was encountered. The air flow is about 1 cubic foot per hour.

Preliminary runs were made with 10 per cent NaOH, but voltages of 20 to 25 v were too high. A 15 per cent solution at 5 v proved satisfactory.

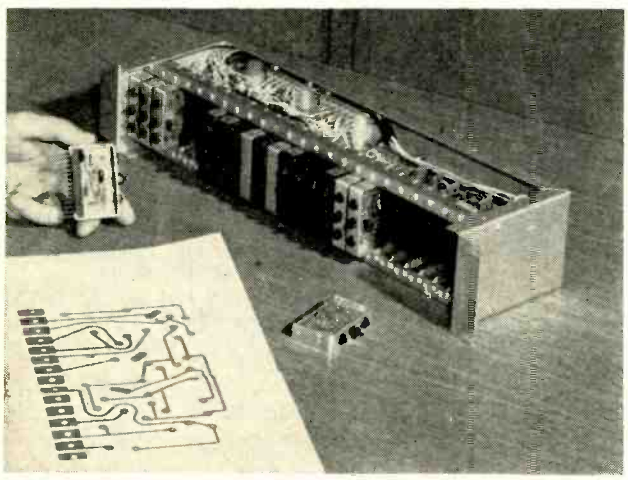


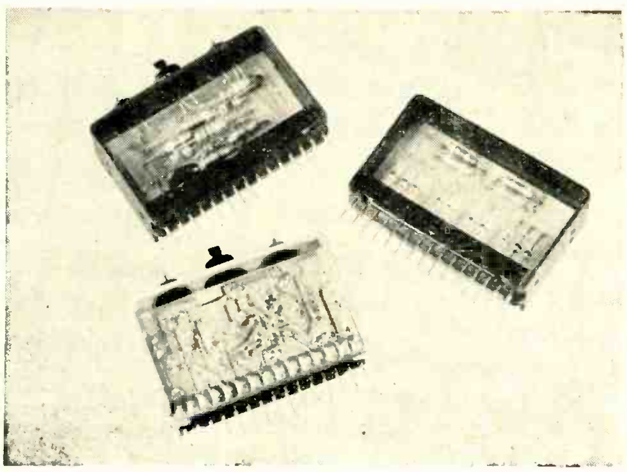
Transistors move through etching station, three rinses and final air-dry before being lifted from holding fixtures by arm at right

The final design was incorporated on a turntable consisting of 1 etching station, 2 hot deionized water rinses, 1 alcohol rinse and 1 air jet. The water removes etching solution, the alcohol removes water to insure rapid drying and the air jet helps remove water and alcohol from the etched region around the base contact. This technique reduced I_{co} rejects by 10 percent.

This scheme was also tried with germanium cut bars, which have a rough surface after sawing. Sawed

DESIGN TRENDS: Transistorized Logical Circuits





Uniform size of miniature computer logical building blocks is achieved by transistor mounting method used by Avco Research and Advance Development Division, Lawrence, Mass. Transistors, mounted on leads bent parallel to printed circuit board, extend through pre-punched holes in front of anodized aluminum U-frame. Each of eight basic logical circuits measures 2.5 by 2 by ½ inch, enabling 25 blocks to be placed in any order in a 19-inch mounting rack. Boards are fabricated in normal manner and dip soldered after base connectors are attached. Insulating washer-collars are placed on transistors and assembly is guided into frame bosses. Fingers at the open ends of the U-frame are bent into grooved ends of the connector, locking circuit in place. The blocks are in prototype production for use in desk-sized and general purpose combat computers.

New trends and developments in designing electrical products . . .

"Work backward"—a new design approach that's bringing the advantages of General Electric permanent magnets to fields traditionally reserved for electromagnets

A new approach to the design of motors, generators, relays, and similar products is making it possible to produce smaller, more efficient and economical units by using permanent magnets, instead of electromagnets.

The new approach is simply to "work backward." That is, design the most efficient magnet assembly first, and then the rest of the component.

In the past, where designers tried to replace electromagnets in these products, permanent magnets often proved uneconomical. Here's why:

The traditional approach was to work the permanent magnet into an *existing* design for a wire-wound field, to save the cost of new dies and other major manufacturing changes.

Under these conditions, permanent magnets will seldom show to best advantage. But, by using the "work backward" approach, many outstanding results can be obtained.

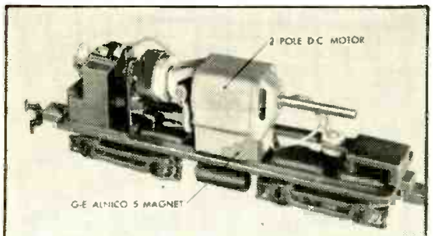


FIGURE 1 — G-E Alnico 5 magnet helps 2-pole motor develop 1/150 hp at 10,000 to 15,000 rpm.

For example, permanent magnets had been limited to fractional-hp applications, such as the 1/150-hp toy-locomotive motor in Figure 1.

But today, through imaginative design and more efficient alloys, permanent magnets are now used for rotors and stators in much larger equipment.

The DC tachometer generator in Figure 2, for example, uses a 2-lb. G-E Alnico 6 stator.

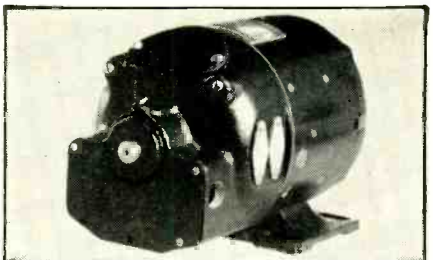


FIGURE 2 — 46-frame DC tachometer generator with Alnico 6 stator.

The permanent magnet provides greater reliability and accuracy than copper windings, over wide ambient temperatures. It eliminates an external power source and field regulating equipment. And, there is no replacement problem since the magnet — unlike wire — never burns out.

These are some of the advantages that can be realized from early consideration of the permanent magnet in design.

Alone, these can more than justify the cost of redesigning equipment to eliminate wound fields. Yet, there are other advantages that result from the magnet's ability to supply a constant field without external excitation, including:

- Elimination of field interruptions due to power failure.
- Elimination of heat and need for costly cooling equipment and insulation — thus conserving valuable weight and space.
- Elimination of danger from faulty wiring or damaged insulation.

These are important advantages where equipment must be reliable despite severe environmental conditions. But equally important to the designer is the permanent magnet's superior volumetric efficiency. A G-E Alnico magnet can usually supply a given magnetic field in a fraction of the space needed by even the best designed electromagnet.

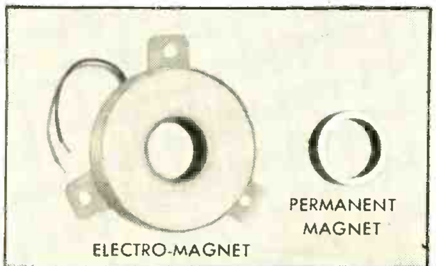


FIGURE 3 — TV-tube focusing magnets.

The TV-tube focusing magnets in Figure 3 gives some idea of the savings in space and weight a designer can effect.

The electromagnet weighs 2 lbs., and takes up 16.35 cubic inches. The G-E Alnico 5 permanent magnet weighs just 15 ounces, and requires only 1.30 cubic inches — a space-saving of 87%.

In addition to the problem of economics, two other traditional objections to permanent magnets have also been largely eliminated:

First, early permanent magnets were relatively unstable. But modern permanent magnet materials from improved manufacturing techniques are really "permanent" . . . even under temperature and humidity conditions ruinous to electromagnets.

Second, applications requiring "on-off" field action seemed outside the capabilities of permanent magnets. But modern design techniques have developed practical ways to handle this by shunting flux around the air gap.

With the new high-energy alloys and the development of more scientific design methods, the future for permanent magnets—and the opportunity for designers — is virtually unlimited.

For example, a recent use of the "work backward" approach has, for the first time, made it possible to use powerful Alnico magnets to supply uniform fields in equipment like traveling wave tubes.

General Electric Magnet Engineers have accumulated a wealth of information on the problems of redesigning for permanent magnets. They will share their knowledge with you at any stage of the magnet design project.

For more information, or the services of a G-E Magnet Engineer, write: *Magnetic Materials Section of General Electric Company, 7806 N. Neff Ave., Edmore, Michigan.*

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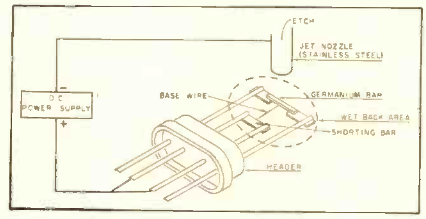
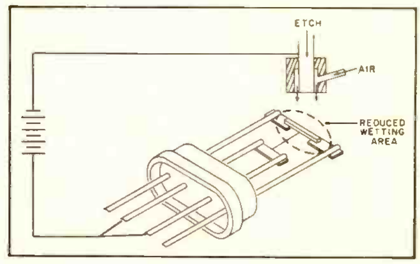
GENERAL ELECTRIC

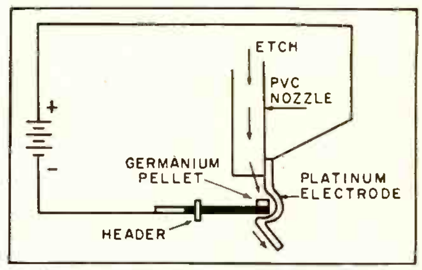
pellets were mounted on headers and etched with the same machine. However, sodium or potassium hydroxide would not produce a mirror surface finish.



Shorting bar was wetted in preliminary design (Fig. 1)



Air jet in nozzle restricts flow (Fig. 2)



Reversed polarity, redesigned nozzle for sawed bars (Fig. 3)

A 1:1 part HF to HNO_3 acid produced best results. Nozzle material was changed from stainless steel to polyvinylchloride with a platinum electrode, to avoid corrosion. Redesign (Fig. 3) also overcame another difficulty, dependence of the etching upon the velocity of the etching stream.

Reversing the polarity used in the previous scheme caused the pellet to act as the cathode. The former polarity resulted in etch pits and pockets while the reversed polarity gave a mirror finish.

Salvaging Color Masks

COSTLY 300,000-hole shadow masks for color picture tubes, previously scrapped even for slight dents, are now salvaged in RCA's Lancaster,

Tapping shadow mask with rubber hammer to remove dents, while shaped mandrel underneath provides support

Pa. plant by using techniques of auto body-and-fender mechanics. The dented mask is placed over a mask-shaped supporting form, then tapped with a rubber-faced hammer until correct curvature is restored. The idea brought a suggestion award of $1,792 to assembly inspector Eva Weidman.

Strong, Light Radome Is Foam Polystyrene

By H. L. Loucks
Special Weapons Division
Bell Aircraft Corp.
Buffalo, N. Y.

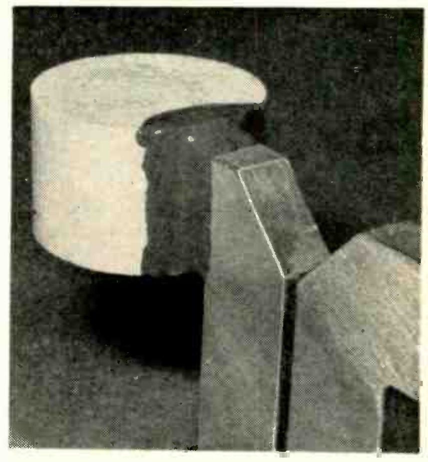
PRE-EXPANDABLE POLYSTYRENE provides a strong, lightweight foam for molded structures. Discussed here is its use as a pressurized radome for waveguide feed assemblies, preventing electrical breakdown at high altitudes.

The foam radome, at density of 5 pounds a cubic foot, will withstand a pressure differential of 5.3 psi or, with Fiberglas reinforcement and production refinements, 30 psi.

Polystyrene beads, placed on corrugated cardboard, are partially pre-expanded for about 30 seconds at 180-230 F with 4 250-watt infrared heat lamps placed 3 inches above the beads. When a mono-layer, lace-like network has formed and the beads have expanded 20-25 times original volume the layer is removed from heat, cooled and broken into individual beads.

Pre-expansion is rapid and critical. If beads are left under heat too long, they will no longer expand in the mold or will collapse. The amount placed in the mold depends on size and density desired. Both weight and volume of pre-expanded beads must be considered for consistent results.

A closed 2-cavity, 5-piece, 2024

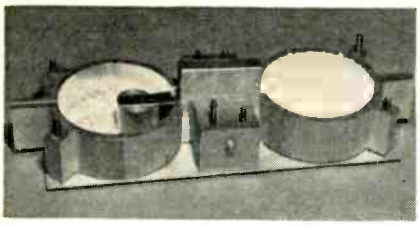


Reinforced polystyrene foam radome withstands 30 psi

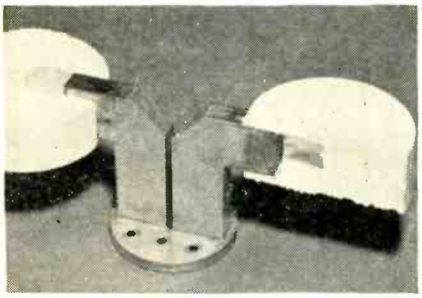
Heat of infra red lamps pre-expands polystyrene beads

aluminum mold and dummy wave guide feed are used to form the radome. Top and base plate have a $\frac{3}{32}$ inch perforation for each 2 square inches of cavity area to allow dry steam to enter. The dummy feed has a 1 inch diameter sectionalized removable core.

A $\frac{1}{8}$ inch layer of beads is placed in the mold and the dummy positioned. The mold is filled with the remaining charge of pre-expanded beads. The assembled mold is placed



Two-cavity mold with dummy waveguide feed positioned on layer of beads (left) and filed with beads (right)



Cutaway radomes show how they slip onto adhesives-coated waveguide feeds

in a vacuum impregnating tank preheated to 250 F. The polystyrene is steam-expended for 1.5 minutes at 55-60 psig and 270 F.

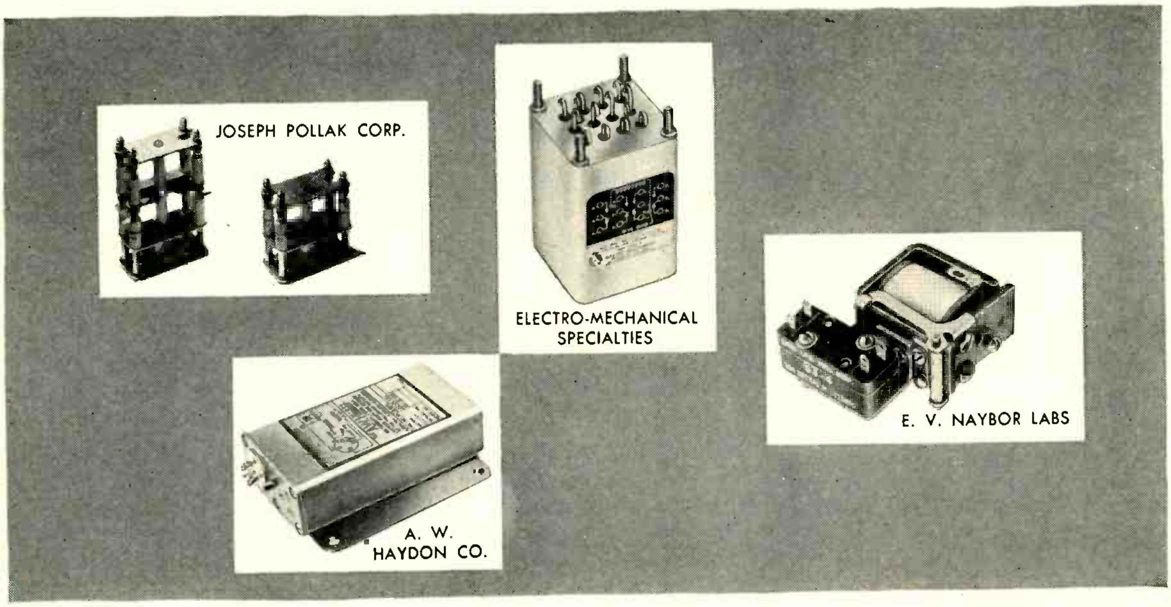
After removal, the mold is cooled in water until the radome's temperature drops below 100 F. The radome is gently freed from metal mold parts and abraded with 60 grit sandpaper.

The wave guide feed is cleaned with cloth and methylene chloride. Water-based acrylic emulsion is applied and the radome slipped on. Emulsion is filleted on faying surfaces and air pockets resealed. After a 30-minute air dry, a second coat of emulsion is applied. Top and bottom of the radome is sealed with two coats of emulsion and the whole is air dried 24 hours.

Modifications increase bursting strength to 30 psi. Height of the cavity is decreased to make walls 0.060 inch thicker. Fiberglas discs 0.0035 inch thick are cemented with the acrylic emulsion to top and bottom. A filled epoxy and Fiberglas strip fillet are used to bond the radome to the feed. Feed surface is improved by abrasion and cleaning with a phosphoric acid, alcohol cleaner.

This article was adapted from a paper presented by H. L. Loucks and H. J. Lauer at the Biennial Electronic Materials Symposium, Philadelphia. The author thanks H. G. DeBan, a co-worker, for cooperation in providing information.

Step Up Relay Production



Emphasize Reliability

ACHIEVEMENT of superior performance and reliability in missile and airborne applications as well as for critical industrial uses is a prime consideration among relay manufacturers. This is reflected in the latest designs.

Electro-Mechanical Specialties Co., Inc., 1016 N. Highland Ave., Los Angeles 38, Calif., (275), has introduced the No. 410LL relay designed to meet the requirements of MIL-R-5757 C and MIL-R-6106 C. It combines the functions of a dry circuit relay with those of a high current relay, from 1 μa at 5 mv to a 10 ampere resistive/inductive load.

Subminiature hermetically sealed time delay relays announced by **The A. W. Haydon Co.**, Waterbury, Conn., (276), are designed for aircraft, missile and rocket applications and will also be used by industry where space and weight are at a premium. Time delay settings from 1 sec to 1 hr can be supplied on d-c units, and from 15 sec to 3 hr on 400 cps units.

E. V. Naybor Laboratories, Inc., 26 Manorhaven Blvd., Port Washington, N. Y., (277), has available type R310 which provides a compact power relay for switching high currents with the utmost reliability. Nominal coil resistance for 26.5 v d-c is 300 ohms. Coil resistance values are available to 10,000 ohms. Contact rating is 10 amperes at 125 or 250 v a-c, or 10 amperes at 30 v d-c inductive.

Two small, compact d-c high voltage switching relays are offered by **Joseph Pollak Corp.**, 81 Freeport St., Boston 22, Mass., (278). They are suited for radar, sonar, missile and other severe environments. Featuring high dielectric strength, the lightweight units are designed to withstand severe shock, vibration, an ambient temperature range of −55 to +95 C and a minimum of 500,000 operations.

For more information use **READER SERVICE CARD**

Interval Timer a precision unit

THE A. W. HAYDON CO., Waterbury, Conn., has announced a new series of precision interval timers. These hermetically sealed units use the basic construction of a repeat cycle timer, but with a novel switching system which allows high accuracy over long range timing intervals.

Available with either chronometrically governed d-c motors or synchronous a-c motors, these units are supplied with accuracies of 1 percent or better.

Range of adjustment is determined by the application requirements in each instance, and overall ranges in excess of 30 to 1 can be supplied readily.

Besides establishing a precision-

When you specify Cornell-Dubilier capacitors, you can be sure that nothing is left to chance. Production procedures, test and inspection operations and quality control are in full compliance with Cornell-Dubilier high-quality standards and *your* specifications. Quality and Reliability are talents we have cultivated since 1910. That's why you can count on the consistently dependable facilities of C-D's 16 plants!

Typical C-D paper tubulars:

TIGER CUB*: Cardboard-cased paper tubular with Polykane(1) end-fill. Vikane-impregnated for excellent capacitance stability. High moisture resistance. Operating temperature range: –55°C to +100°C.

TINY CHIEF*: Small, all-purpose paper tubular, molded in extra-hard thermosetting plastic for long-lasting all-around satisfaction. Available with high temperature wax impregnant for operating temperature range –40°C to +90°C and Vikane or Polykane* impregnant for –55°C to +100°C operation.

ROYAL CUB*: Cardboard-cased paper tubular with Polykane* end-fill. Tough, durable, withstands rough handling, vibration, shock, soldering iron heat. Operating temperature range: –55°C to +100°C.

BUDROC*: Steatite-cased paper tubular. Polykane* end-fill for extra protection against heat and humidity. High temperature wax impregnant for operating temp. range –40°C to +90°C and Vikane impregnant for –55°C to +100°C.

(1) Polykane: A development of the C-D laboratories. A solid thermosetting compound will not crack, soften or flow.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-DEPENDABILITY
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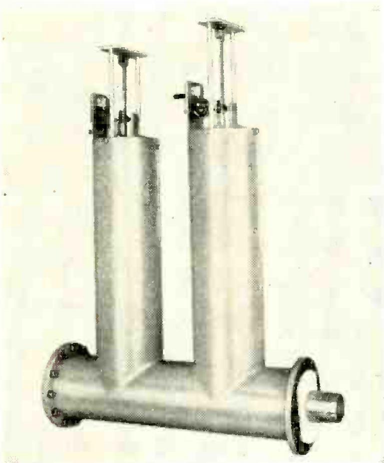
timed interval which can be maintained in either the open or closed position at the duration of timing, this unit can also supply an auxiliary circuit closure for reference or power use at the conclusion of the timing program. Circle 279 on Reader Service Card.



Coax Double Tuner for 425 mc region

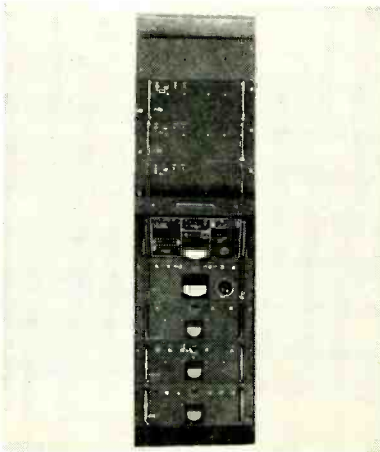
CONTINENTAL ELECTRONICS MFG. Co., 4212 S. Buckner Blvd., Dallas 27, Texas, offers a new 6⅛ in., 50 ohm coaxial double tuner designed for use in the 425 mc region, and for high power operation. The new tuner (type C6-T) has two shorted coaxial stubs, spaced ⅜ wavelength apart at 425 mc. The rack and pinion short mechanisms may be optionally equipped with servo drives or may be manually adjusted with calibrated control knobs. Circle 280 on Reader Service Card.

Accelerometer self-calibrating

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., has developed a self-calibrating accelerometer designed primarily for control and guidance in aircraft and missiles. Other applications include fire control, servo guidance and pitche and yaw correction characteristics.

Model ADT-905 is equipped with a self-contained calibration system which can be used to check the operation of the accelerometer while in use, or to calibrate the accelerometer statically or dynamically. This transformer accelerometer is inherently stable over the range −65 F to +250 F because of its balanced electrical and mechanical construction.

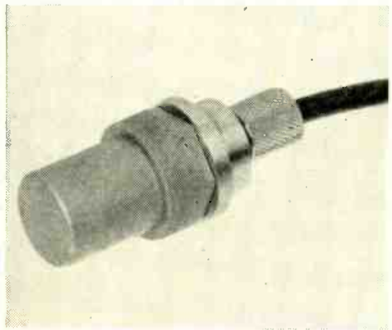
Operating at a low natural frequency of approximately 30 cps, the accelerometer maintains stable frequency response characteristics over the temperature range as a result of magnetic damping. Circle 281 on Reader Service Card.



SSB System rugged design

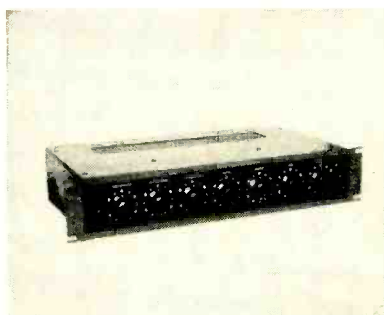
KAHN RESEARCH LABORATORIES, INC., 22 Pine St., Freeport, N. Y., announces the compatible single-sideband transmitter adapter. The new technique is offered to the radio broadcast and h-f communications industry as a major state-of-the-art improvement in the transmission of speech and music. The system is designed to convert any standard high-level, low-level or Doherty type a-m transmitter to a new and improved type of ssb operation. Transmitters can be adapted without engineering modifications and reception is completely compatible on all existing a-m receivers.

Rugged, conservative design insures compliance with continuous operational requirements, including remote station operation. The adapter includes a unique multipurpose test unit, permitting simple and direct measurements of desired and undesired sidebands and associated equipment. Circle 282 on Reader Service Card.



Pressure Transducer for liquids or gases

PHILLIPS & HISS CO., INC., 1145 N. McCadden Place, Hollywood 38, Calif., announces a new flush diaphragm pressure transducer, a-c variable reluctance type. It is especially suited for use in corrosive environment as diaphragm and case are one piece machined from the solid of stainless steel. It features high output, approximately 1 v with 20 v excitation; is available in ranges from 0-100 to 0-3,000 psi; nonlinearity, ± 0.5 percent of full scale; 1-in. diameter diaphragm by 2¼ in. overall length; weight, 7½ oz. Circle 283 on Reader Service Card.

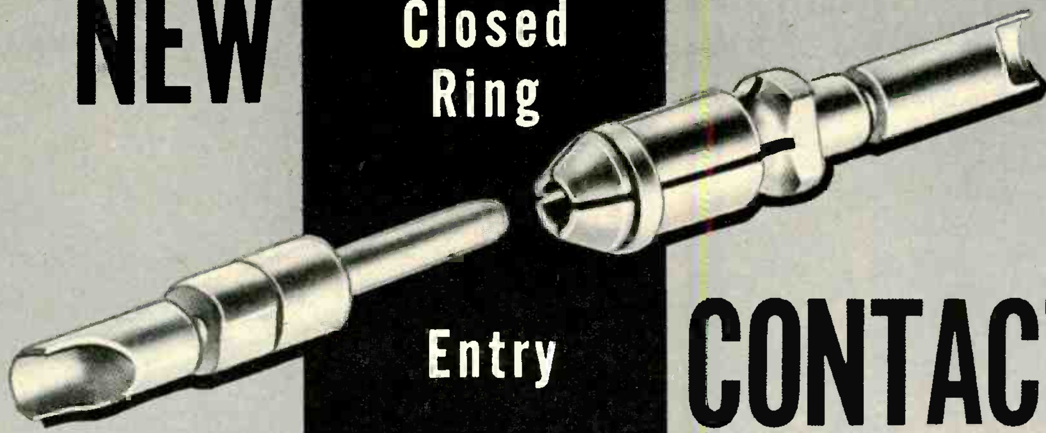


Audio Mixer for recording systems

THE MIAMI INSTRUMENT CO., Box 384, Tamiami Station, Miami 44, Fla., is now marketing a versatile audio mixer for use with recording

Continental Connector ***announces...***

NEW Closed Ring Entry CONTACT*



3½ TIMES ACTUAL SIZE

CLOSED ENTRY DESIGN . . . FOR 100% MORE RELIABILITY

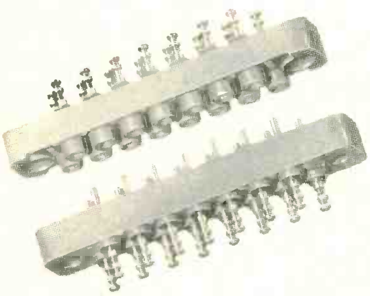
A solid ring limits socket contact expansion to maximum tolerance of pin diameter. This prevents over-stress of the individual socket contact leaves and possibility of any contact distortion. Also, an oversized probe cannot enter the socket contact. Even "rocking" and "prying" actions will not distort the contact.

Constant and uniform insertion pressure is guaranteed while a consistently low millivolt drop is maintained. The new contact was developed for use in intercontinental ballistic missiles and other applications requiring high reliability. It is another example of Continental Connector's constant research into improved design.

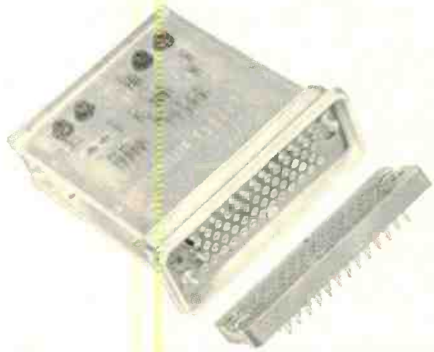
Technical brochures on various Continental Connectors are available free on request. Specify your requirements to Electronic Sales Division, DeJur-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y.

- ★ Solid Construction—Cannot be Forced Out of Shape
- ★ Extremely High Reliability—Indestructible in Normal Maintenance
- ★ Maintains Low Millivolt Drop Under Constant and Uniform Insertion Pressure
- ★ Terminations Include Solder Cup, Turret, or Solderless Taper Pin (Solder Cups can be hot pre-filled, if desired.)

AVAILABLE IN ALL STANDARD CONTINENTAL CONNECTORS



15 Contact Plug and Receptacle with New Closed Entry Contacts and Turret Terminals.



Continental Connector and New Closed Entry Contacts Used with Printed Circuit Application for Classified Intercontinental Ballistic Missile.

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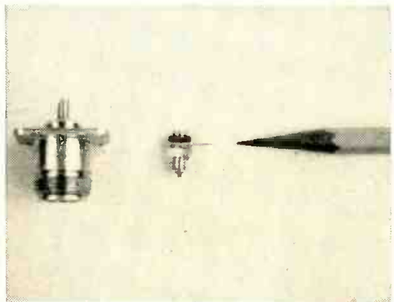
and p-a systems. It features plug-in transformers, preamplifiers and line amplifiers. The plug-in units may be arranged to provide up to seven individually controlled input channels. Outputs of +20 dbm into 50, 250 or 600 ohms, or up to 30 v into high impedance may be obtained from the line amplifiers.

The inputs may be microphones, tape or disk players, tuners and so forth. Model 17 (rack mounting) is pictured. Sloping panel and custom models are also available. All models are approximately 3½ in. high. **Circle 284 on Reader Service Card.**



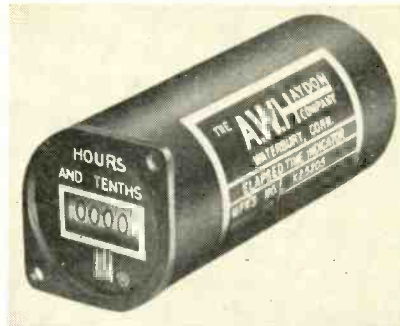
Tiny Connectors for small cables

KINGS ELECTRONICS CO., INC., 40 Marbledale Road, Tuckahoe, N.Y., announces a new series of sub-miniature connectors for cables RG-141A/U and smaller cables. These connectors are interchangeable with other sub-subconnectors in the field. They are made in gold or silver plate. All contacts are gold for ease of assembly. They are designed for missile and computer applications requiring highest precision and reliability.

The illustration shows the comparison in size between connector UG-58A/U and the new series. **Circle 285 on Reader Service Card.**

Power Supply low-voltage unit

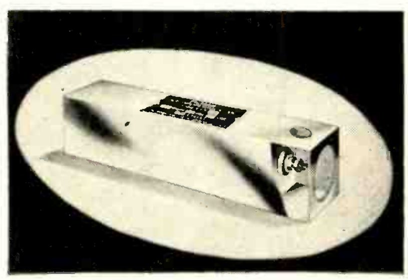
NELSON INSTRUMENT CO., 607 Howard St., Evanston, Ill., announces its new low-voltage, medium-current power supply designed for such applications as production testing of semiconductor products. It operates on 115 v, 60 cps input yielding continuously variable voltages of 1.5 to 15 v. Output current is 0 to 1.0 ampere with 0.5 percent output ripple and regulation. Response time is better than 50 millisec with stabilization being achieved with a Zener reference diode. It is available in rack or cabinet models. **Circle 286 on Reader Service Card.**



Indicators show elapsed time

THE A. W. HAYDON CO., Waterbury, Conn. The new subminiature hermetically sealed elapsed time indicators are designed to meet military requirements and are now available with 400 cycle motors, for operation on 115 v. These 25200 series units are available with two dial styles and two mounting options.

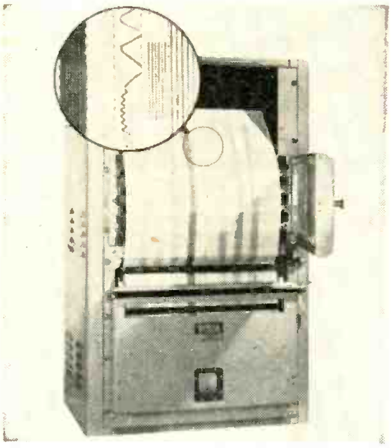
Shown is the digital version with compact flange mounting. A five-digit non-reset type counter totalizes to 9,999.9 hr. The last digit, color coded red, reads tenths of hours, while the first four digits read whole hours. **Circle 287 on Reader Service Card.**



Screen Room Filters extended range

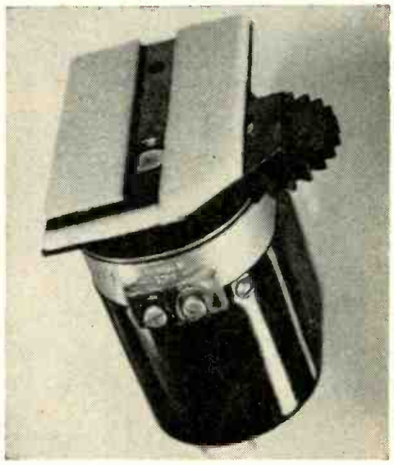
FILTRON CO., INC., Flushing, N. Y. A new series of r-f interference suppression screen room filters provide attenuation characteristics of 100 db and above at frequencies from 14 kc to 10,000 mc. The FSR-1200 filters are designed for use in circuits carrying 25 to 200 amperes, for voltages up to 250 v a-c or 600 v d-c, and power line frequencies of 0-400 cps. The increase in effective range of 100 db attenuation was necessitated by the accelerated use of frequencies higher than 1,000 mc in numerous military and commercial projects; and to meet the requirements of the new Specification MIL-I-6181C.

All components are designed for continuous operation. Assembled filters are 100 percent tested for voltage breakdown, characteristic insertion loss, voltage drop, insulation resistance and hermetic seal, before shipment. Circle 288 on Reader Service Card.



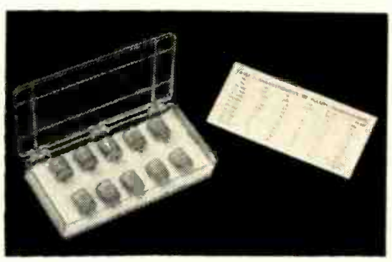
Graphic Recorder for telemetry

HOGAN LABORATORIES, INC., 155 Perry St., New York 14, N. Y. Digital data reduction, telemetry output recording, spectrum analysis work and general off-on event displays are uses for the new 450 trace quick-look direct instrument recorder. Using low cost wide dynamic range electrolytic Faxpaper, the multichannel RX-48 produces 450 immediately visible, black on white 0.015 in. traces across 14 inches of a 15 inch sheet, which advances at one of ten discrete speeds up to 12 ips. The multi-styles event recorder has a 400-ft continuous roll chart capacity, which lasts about six minutes of operating time at maximum chart feed. Convenient record duplicates can be produced on standard drafting room copying machines. **Circle 289 on Reader Service Card.**



Plastic Foam Tape reduces vibration

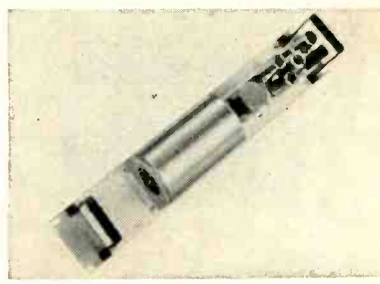
United Mineral & Chemical Corp., 16 Hudson St., New York 13, N. Y., is marketing Tesamoll, a new polyurethane, plastic-foam, self-adhesive tape. Radio and electronic equipment manufacturers find it useful for the mounting of speakers to improve fidelity and the quality of reproduction. Television manufacturers use it as a sealing material in the front assembly of the screen to prevent the entering of dust particles attracted by the high electrostatic charge of the tv tube. Illustrated is its use as a base cushioning for the metal housing of an electric motor to eliminate resonance. **Circle 290 on Reader Service Card.**



Transformers for pulse circuits

Airpax Products Co., Middle River, Baltimore 20, Md. Design of blocking oscillators is greatly simplified by this kit of transformers. The transformers are specifically designed for use in preferred blocking oscillator circuits. For example, in NBS preferred circuit No. 46, cathode output is 60 to 85 peak volts with pulse durations of 0.1 to 10 μsec, depending on transformer used. Kit consists of 8 oscillator units with turns ratios of 1:1:1 and open-circuit primary inductances from 0.08 to 158 millihenries and 2 interstage units with turns ratios of 5:1:1. The 10 Pulsite transformers are packed in a convenient plastic box for laboratory use. All units plug into 7-pin miniature tube socket for convenience in determining prototype requirements.

Transformers are built to meet MIL-T-27A, grade 1, class R specs. They are hermetically sealed, insulated to withstand hipot of 500 v d-c between windings and from windings to case. They operate from − 55 C to + 105 C. Maximum average power rating is 2 w. Maximum duty cycle is 0.05. Approximate dimensions are ¾ in. diameter and ⅞ in. seated height. **Circle 291 on Reader Service Card.**



Crystal Oven controlled unit

Manson Laboratories, Inc., P. O. Box 594, Stamford, Conn. Oven temperature variation is held to 1/1,000 of the ambient temperature change in a new proportionally-controlled crystal oven. Called the RD-130, the complete unit consists of two compact assemblies—a thermo-oven, which accommodates an HC-6/U crystal holder, and an oven control amplifier—both mounted on a 3½ in. high standard 19 in. relay-rack panel, but with subassembly packaging arrangements available as needed.

B+ and filament power of 250 v d-c at 70 ma and 6.3 v a-c at 1.8

amperes are required for the control amplifier, which provides the temperature-controlling power to the oven. Only a single element, a temperature-sensitive resistance bridge, is used both for oven heating and for sensing change in temperature. The oven temperature is normally provided set at 75 C, but is also available preset at any temperature from 10 C to 100 C above ambient. Vernier temperature adjustments are possible.

The oven is usable over the military environmental temperature range. **Circle 292 on Reader Service Card.**

Frequency Standard tuning fork type

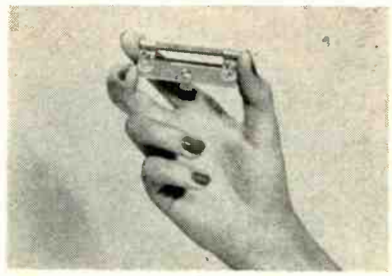
ACCURATE INSTRUMENT CO., INC., 2422 Branard St., Houston 6, Texas, announces a new frequency standard of the tuning fork type. It will stay within specified tolerance under all conditions within specifications. The standard is self contained and requires only 12 v d-c or 30 v d-c to give the output signal. Total current drain at 12 v d-c is approximately 4 ma.

Tolerance of ±50 parts per million from absolute frequency can be maintained under any combination of the following: temperature from 55 C to +100 C, power supply deviation ±15 percent; operation in any position.

Frequency ranges are from 400

cps to 8 kc. Case size is 1⅝ in. by 1⅝ in. by 2⅜ in. Applications are: (1) controlling drive speed of motors in recording systems, servo systems, navigational systems and in other systems that require very constant speed motors. (2) Supplying time bases for various recording systems. (3) Synchronizing two or more remote systems with each other. (4) For use as primary standard for other frequency generators of less accuracy.

The unit is priced from $180 to $255 depending upon tolerance required. **Circle 293 on Reader Service Card.**



Surgistor cuts service calls

WUERTH TUBE-SAVER CORP., Detroit, Mich. The new 4000 series Surgistor offers a unique means of low-cost surge protection to eliminate destructive in-rush currents in all electronic devices.

The Surgistor combines the functions of a resistor and a relay. It limits the in-rush current until the tube heaters are warmed sufficiently to accept the full voltage without damage. In addition, B plus voltages are temporarily held down to prevent cathode stripping.

This product will provide a new standard of reliability for all electronic equipment using tubes, such as film projectors and electric organs. It can be installed by the manufacturer as original equipment. **Circle 294 on Reader Service Card.**

Epoxy Casting with nonsettling feature

HOUGHTON LABORATORIES, INC., Olean, N. Y. Four new additions to the Hysol 6900 epoxy casting product series have been an-

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MAR. 28	APR. 4	APR. 11	APR. 18
APR. 25	MAY 2	MAY 9	MAY 16
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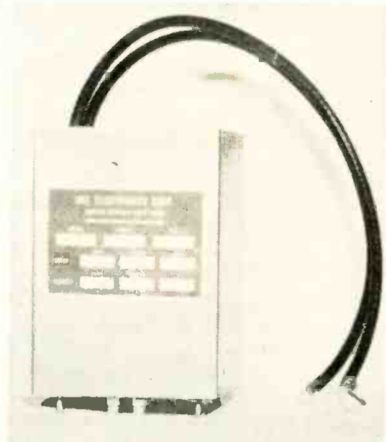
nounced. This series, especially designed for the casting of transformers, coils, magnetic amplifiers and other similar equipment, incorporates longer pot life, low viscosity and the elimination of settling. Thus a new ease of handling is attained, and these products are more suitable to continuous production techniques. The nonsettling feature reduces the problems encountered in storage and preparation. Another advantage is flexibility which prevents cracking caused by temperature cycling and shock, often called for by MIL-T-27A. **Circle 295 on Reader Service Card.**

A-C Ratiometer extremely accurate

TRANSFORMERS, INC., 200 Stage Road, Vestal, N. Y. An a-c ratiometer capable of measuring a-c voltage ratios between 0.000001 and 1.111111 with extreme accuracy and at any load has been announced. With an accuracy of five parts per million at unity ratio, the instrument is particularly well adapted for testing precision transformers, resistors, capacitors and inductors used in computers or other critical circuitry.

Two models are available providing an overall frequency range of from 40 cps to 2,000 cps. The instrument is normally furnished with plug-in units for operation at 60 cps (model 206) or 400 cps (model 204). Other plug-in units are available on order to cover any specified frequency.

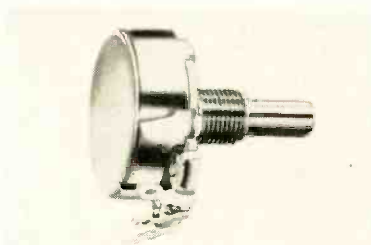
The unit employs an a-c bridge circuit with a variable transformer in the balance arm of the circuit. Effects of quadrature and harmonics are eliminated by quadrature voltage injection and filtering. A transistorized amplifier provides enough gain to feed the null signal directly to the deflection plates of an external oscilloscope which serves not only as a null indicator, but also as a direct reading indication of quadrature voltage injection. Circle 296 on Reader Service Card.



H-V Power Supplies compact design

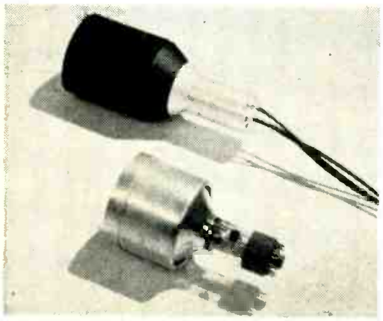
DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N.Y. Model 10-1-1 is one of a new series of power supplies. It will deliver 10 kv d-c at 1.25 ma with an rms ripple of 0.25 percent at 60 cps or 0.04 percent at 400 cps. The dimensions are 3 by 3½ by 5½ high.

These supplies feature reversible polarity, shielded polyethylene output cables and selenium rectifiers. The entire unit is imbedded in an epoxy resin and hermetically sealed. Extremely compact design for mounting on chassis is one of its outstanding characteristics. Circle 297 on Reader Service Card.



Variable Resistor meets MIL-R-94B

CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind. A new high temperature 2-watt military variable resistor with greater stability and certified to meet MIL-R-94B Style RV4 has been developed. Ambient operating temperature is −63 C to +150 C. Type 96 is available with spst switch, printed circuit terminals and a variety of shafts and bushings. It can also be furnished in 2 or 3 section concentric shaft and straight shaft tandem construction. All insulated parts are non-fungus nutrient high temperature silicon fibre glass construction. New design has closed openings under terminals. Circle 298 on Reader Service Card.



Transducer high-resolution unit

LEVINTHAL ELECTRONIC PRODUCTS, INC., 760 Stanford Industrial Park, Palo Alto, Calif. With the objective of maximizing pulse height and resolution, the new scintillation transducer combines a high-clarity thallium-activated sodium-iodide crystal integrally packaged with a standard 5-in. photomultiplier tube.

Available in any crystal lengths up to 4 in., the packaged detection units are supplied housed in overall mu-metal magnetic shields and complete with preamplifiers. The crystals can additionally be provided with truncated conical ends, drilled wells, or other configurations as desired.

Integral mounting of the crystal and photomultiplier avoids an interface of glass otherwise necessary, and therefore provides optimum optical contact between the two. The combination also simplifies installation and application.

The thallium-activated sodium-iodide crystals are produced in a new facility with emphasis on uniformity of thallium distribution for uniform response to gamma rays

CIRCLE 66 READERS SERVICE CARD

stopped throughout the volume; and optimized clarity with minimum optical absorption particularly in the blue and ultraviolet for the attainment of maximum light to the photomultiplier. **Circle 299 on Reader Service Card.**

Power Supply general purpose

Nutron Mfg. Co., Inc., 67 Monroe Ave., Staten Island 1, N.Y., announces a new portable general purpose, low voltage, high current, tubeless power supply. Model PR-1A is the regulated type especially useful for testing and developing transistor devices, and for basic research. It has wide application wherever a smooth variable source of regulated d-c or a-c is required.

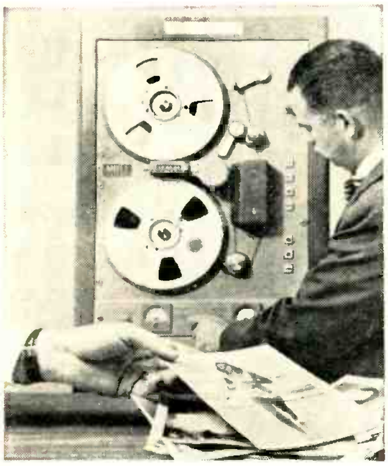
Specifications are as follows: a-c input—95-130 v, 60 cps; d-c output—0-120 v, 0-1 ampere; a-c output—0-130 v, 0-1.5 amperes; regulation—± 1 percent for line variation from 95-130 v. **Circle 300 on Reader Service Card.**

Antenna Positioners rugged, weatherproof

Scientific-Atlanta, Inc., 2162 Piedmont Road, N. E., Atlanta, Ga. A series of rugged weatherproof remotely controlled antenna positioning tables, particularly used for antenna pattern measurements are now available.

The series 411 antenna positioners are designed to support loads up to 800 lb with a maximum unbalance of 2,000 ft lb. The positioner is driven in azimuth by a variable speed reversible motor. Synchro output signals are provided for driving remote indicators and antenna pattern recorders. Remote control and indicator units are also available. Other positioner models include azimuth over elevation rotation and elevation over azimuth.

Prices start at $1,550 for a model 411 with a single synchro signal ratio and speed range. Dual speed range and synchro outputs are also available. Circle 301 on Reader Service Card.



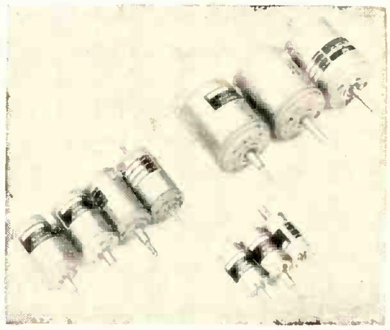
Tape Recorder "remembers" a picture

AMPEX CORP., 934 Charter St., Redwood City, Calif. A new magnetic tape recorder, called the Faxtape machine, makes it possible to transform a photograph into magnetic impulses that can be retransmitted, stored permanently on tape, or converted back to a picture at will. Upon playback the machine "remembers" the original picture with all of its original clarity and detail.

The picture fed into the Faxtape recorder is in the form of the output signal from a standard facsimile transmitter. Once on tape, this signal may be sent to other Faxtape machines with a speed several times that of ordinary facsimile transmission.

The Faxtape recorder has a

built-in time standard of extreme precision, providing playback with a timing accuracy better than two parts in a million. Complete grey-scale fidelity is achieved. Circle 302 on Reader Service Card.



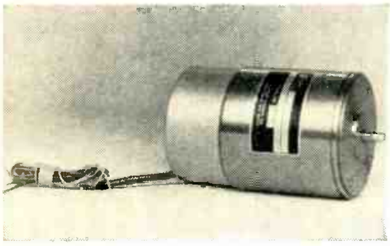
Clutch/Brakes magnetic type

Fae Instrument Corp., 42-61 Hunter St., L.I.C. 1, N.Y., has introduced a complete line of miniature magnetic clutch, brake, and clutch-brakes featuring high precision construction, long life and high torque. Available are 32 different models in BuOrd frame sizes 8, 11, and 18. The complete line features both direct and reverse action. Consistent accuracy and 5 millisec engagement is assured through extra hard coated clutch coupling faces. Temperature range is − 65 F through + 350 F. A complete range of operating voltages is available with 24-28 v standard. They are certified to meet MIL-E-5272A requirements. Circle 303 on Reader Service Card.

Power Amplifier for lab or field

Electro-Voice Inc., Buchanan, Mich. Incorporating the Circlotron output circuit, model 6006 power amplifier finds many uses as an audio and ultrasonic source of power in the laboratory, field or for production testing. The final stage bridge circuit contributes greatly to the unit's fine performance. Extremely low distortion components and a frequency range extending into the ultrasonic region are characteristics found even at maximum rated output.

Model 6006 consists of two seven inch standard rack units, the power supply and the amplifier, and all interconnecting cables. Rated output is 100 w, sine wave, continuous; frequency response, 20 to 50,000 cps, ±0.5 db. Total harmonic distortion is less than 0.3 percent at rated output, intermodulation distortion is less than 0.5 percent. Hum and noise 85 db below rated output. Terminating impedance taps provided are 4, 8, 16 ohm unbalanced, 70 v unbalanced, 600 ohms balanced. Damping factor is 10; input impedance is 250 K; sensitivity is 1.25 v rms. Circle 304 on Reader Service Card.



Synchro high accuracy unit

KEARFOTT CO., INC., 1378 Main Ave., Clifton, N. J., has developed a size 25 high accuracy synchro component having a maximum error from electrical zero of only a half minute. A resolver type unit, this synchro can function as a 4-wire control transmitter, control differential transmitter or control transformer which when used in a 4-wire string to form a typical data transmission system, holds overall system error to less than one minute from electrical zero. The unit may also be modified for operation at either 4,000 or 10,000 cycles.

A compensator winding is provided to maintain the resolver's 30-second accuracy despite variations in temperature and frequency. Circle 305 on Reader Service Card.

Literature of

MATERIALS

Silicone Insulation. Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y. A four-page sheet describes the specifications and physical properties of L-45 silicone oil, electrical grade, a clear dimethyl silicone polymer which is used as an insulating and cooling medium. **Circle 351 on Reader Service Card.**

COMPONENTS

Coax Power Dividers. Microlab, 71 Okner Parkway, Livingston, N. J. Memo No. 9 covers a line of broadband coaxial power dividers. Description, specifications and prices are given. **Circle 352 on Reader Service Card.**

Hermetic Terminals. Thermo Materials, Inc., 4040 Campbell Ave., Menlo Park, Calif. Technical data sheet EC-1225 describes a new line of metallized ceramic hermetic terminals. Types and sizes are listed. **Circle 353 on Reader Service Card.**

Transformers. ESC Corp., 534 Bergen Blvd., Palisades Park, N. J., announces a catalog-folder covering a line of blocking oscillator pulse transformers, coupling transformers, pulse transformer sample kits and the like. It offers operational data, test circuit diagrams, case styles and other data. **Circle 354 on Reader Service Card.**

Transistor Specification Chart. Industro Transistor Corp., 35-10 36th Ave., Long Island City, N. Y., has available a newly revised transistor specification chart which covers the company's *pnp* germanium alloy-junction transistors. The chart contains an interchangeability guide on transistors of all manufacturers for computer, entertainment and industrial applications. **Circle 355 on Reader Service Card.**

Variable Transformers. Ohmite

the Week

Mfg., 3668 Howard St., Skokie, Ill. First model in the company's line of V.T. variable transformers is described in detail in bulletin 151. Pertinent performance data such as voltage regulation and derating curves are also presented. **Circle 356 on Reader Service Card.**

EQUIPMENT

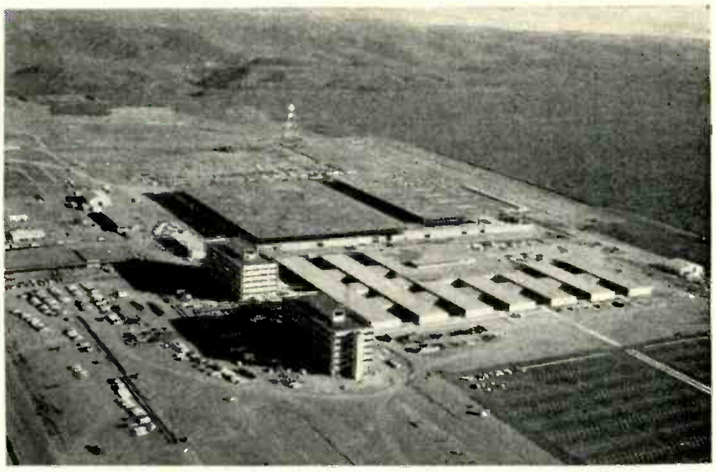
Current Pulse Amplifiers. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa. Bulletin 57-A describes models 1070 and 1070A high-amplitude current pulse amplifiers. Basic circuit groups are discussed. Application suggestions and detailed specifications are included. **Circle 357 on Reader Service Card.**

Modulated R-F Sources. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. Bulletin No. 40 illustrates and describes three models of stable, modulated sources of r-f power for measurements in the frequency range of 50 to 2,000 mc. Prices are included. **Circle 358 on Reader Service Card.**

Soldering Irons. General Electric Co., Schenectady 5, N. Y. An 8-page bulletin, GED-3553, covers a complete line of the company's soldering irons, which feature light weight, calorized and ironclad tips and tubular heater. Case histories of savings obtained by their use is included. **Circle 359 on Reader Service Card.**

FACILITIES

Instrument Construction System. Gap Instrument Corp., 33 S. Glove St., Freeport, L. I., N. Y., Bulletin ICS165 covers the company's instrument construction system. With the system described it is possible to reduce the clapsed time for producing servo computing units and gear trains from months to days with a sizable decrease in cost. **Circle 360 on Reader Service Card.**



Atlas ICBM Gets New Home

CONVAIR—Astronautics division of General Dynamics Corp. will begin moving personnel and equipment next month into a new $40 million Atlas intercontinental ballistic missile plant (picture) on the northeastern outskirts of San Diego, Calif.

The six-story office buildings in left foreground will house administrative and engineering personnel. The structures are connected by a one-story reception center. The one-story joined buildings arranged in a waffle pattern, at right, will accommodate laboratories, library, reproduction, photographic and other supporting services.

The massive factory area in background will be ready to receive equipment and personnel in April and May. This operating division of the company is responsible for development and pilot production of the Atlas.

Convair-Astronautics now occupies buildings 4 and 8 and part of building 5 at Convair-San Diego. Originally the transfer to the new plant site was to have been made as each of the new Astronautics buildings was completed. This plan was changed, however, to permit the entire division to move in as short a time span as possible to maintain divisional unity.

After Convair-San Diego buildings now occupied by Astronautics' functions are cleared, personnel and offices in buildings 5 and 51 can be transferred to temporary quarters, and a $2½ million remodeling project can proceed. Rehabilitation of the interiors and exteriors of adjoining buildings 5 and 51 is expected to take about 15 months.

The renovation program will involve 400,000 sq ft of floor space in the two buildings. Improvements will provide more efficient and pleasant working conditions for 3,500 to 4,000 Convair-San Diego engineering personnel and will facilitate maintenance, according to B. F. Coggan, vice president and manager.

Among new facilities to be provided is a 9,000 sq ft sloping-floor presentation theater accommodating up to 150 persons. It will be equipped for movie projection and will be used in group program conferences and for discussions among customers and engineering personnel.

Engineers Form New Company

A GROUP of senior engineers formerly associated with the electronics and instrumentation division of the Baldwin-Lima-Hamilton Corp., have organized a new firm, Metrix Corporation, in Newton, Mass. The new company will manufacture instrumentation for use with strain gages and strain gage devices, and will fabricate specially engineered systems based on these devices.

Stanley Charren, former sales manager at BLH, will handle sales and finance, with Malcolm Green, former assistant chief engineer, and David J. First, former chief systems engineer, handling the manufacturing and engineering respectively.

The company's first product will be a test bridge to produce very accurate millivolt per volt signals to check out system instrumentation.

Magnavox Ups Hawkins

RECENTLY promoted to the post of guided missiles advisory engineer for the Magnavox Co., Fort Wayne, Ind., Walter G. Hawkins (picture) will head a newly formed department coordinating various laboratory and production facilities for the firm.

The Magnavox executive will help the company expand its facilities at the Ft. Wayne, Urbana, Ill. and Los Angeles laboratories in the areas of guidance, fuzing, test equipment and weapons system design for several types of missiles and space vehicles.

During the past seven years, Hawkins has been in charge of the development and design of various

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The straight inside story on the new series 5000 is available in data file 22A.

Helipot Corporation, Newport Beach, California
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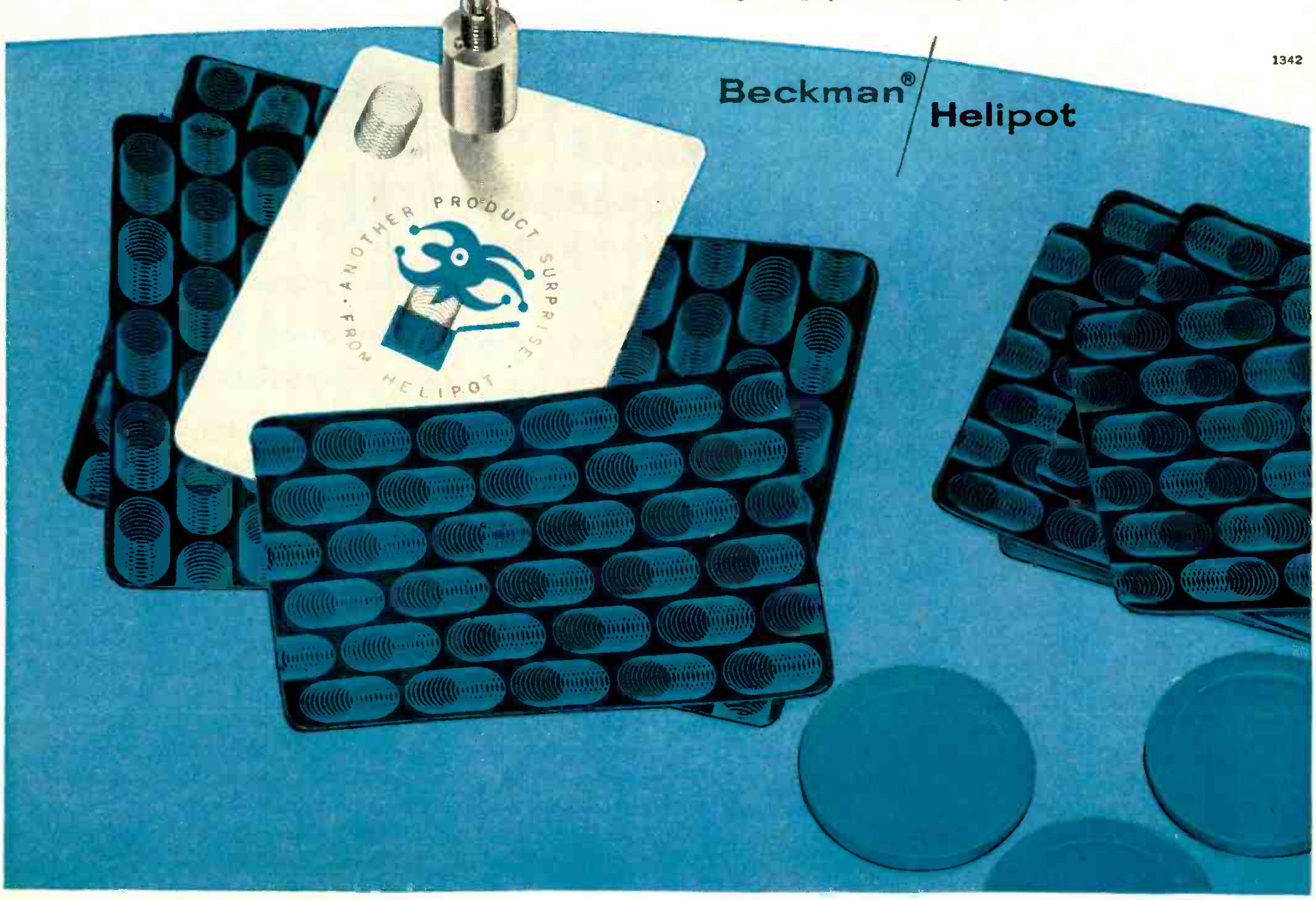

phases of the guidance systems for the Falcon, Terrier, Talos, Sparrow II and Bomarc missiles.

Allis-Chalmers Promotes Eagan

New chief engineer of the control department of Allis-Chalmers Mfg. Co., Milwaukee, Wisc., is W. F. Eagan. He joined A-C in 1947 and for the last six months had been engineer-in-charge of control engineering. Prior to that he had been supervisory engineer of regulator engineering and circuit development in the department.

Mueller Takes New Post

Chicago Aerial Industries places Andrew A. Mueller (picture) in the newly created post of chief of engineering laboratories. During the past seven years with CAI, he has been a research engineer, supervised prototype development and handled engineering liaison on electrical and electronic development.

Mueller will be responsible for electrical, mechanical, environmental and optical labs, and also for engineering publications. Company facilities provide aerial reconnaissance systems and equipment, and will now expand into other aircraft electronic fields. CAI is supplying new equipment for several missile programs and is vitally concerned with navigation and sensing equipment.

Bulova R & D Names Two V-P's

Appointment of two new vice-presidents at Bulova Rsearch and Development Laboratories, Inc., Woodside, N. Y., is announced.

Theodore K. Steele (pictured above) is named vice president of research and engineering. Formerly he was director of research and engineering for the Laboratories, where he supervised the engineering development groups concerned with missile components, automation systems, and advanced weapon systems.

Oscar Brockmeyer, Jr. is appointed vice president of engineering sales for the Laboratories. He was formerly director of engineering sales and was head of the department developing fuze mechanisms and pyrotechnic devices with ordnance applications.

Advance Kinney At Zenith

By action of the board of directors, Eugene M. Kinney is elected vice president of Zenith Radio Corp. of Canada, Ltd. The Canadian corporation, a subsidiary of Zenith Radio Corp., Chicago, Ill., is located in Windsor, Ontario.

In addition to his new duties Kinney continues as general manager, hearing aid division, of the parent company. He has been associated with Zenith since 1946, in assignments that include every major phase of the company's home office operations.

Philco Advances Dougherty

New chief engineer of Philco Corporation's Automotive Division is James W. Dougherty. With base of operation in Philadelphia, he will be responsible for design and production coordination of electronic products Philco manufactures for the automotive industry.

Having served Philco in many technical capacities since 1942, Dougherty has for the past four years been assistant to Harris O. Wood, chief engineer of television.

Raytheon Ups Standing

A thirteen-year veteran with Raytheon, S. A. Standing (picture), is appointed an assistant to N. B. Krim, vice president and general manager of Raytheon Manufacturing Company's receiving tube and semiconductor operations. In his new position he will perform special assignments on major problems in the engineering, manufacturing and quality control areas. He will also continue his present duties as manager of the cathode-ray tube division.

Standing joined Raytheon in 1932 and worked on electrical, metallurgical and process development engineering problems in re-

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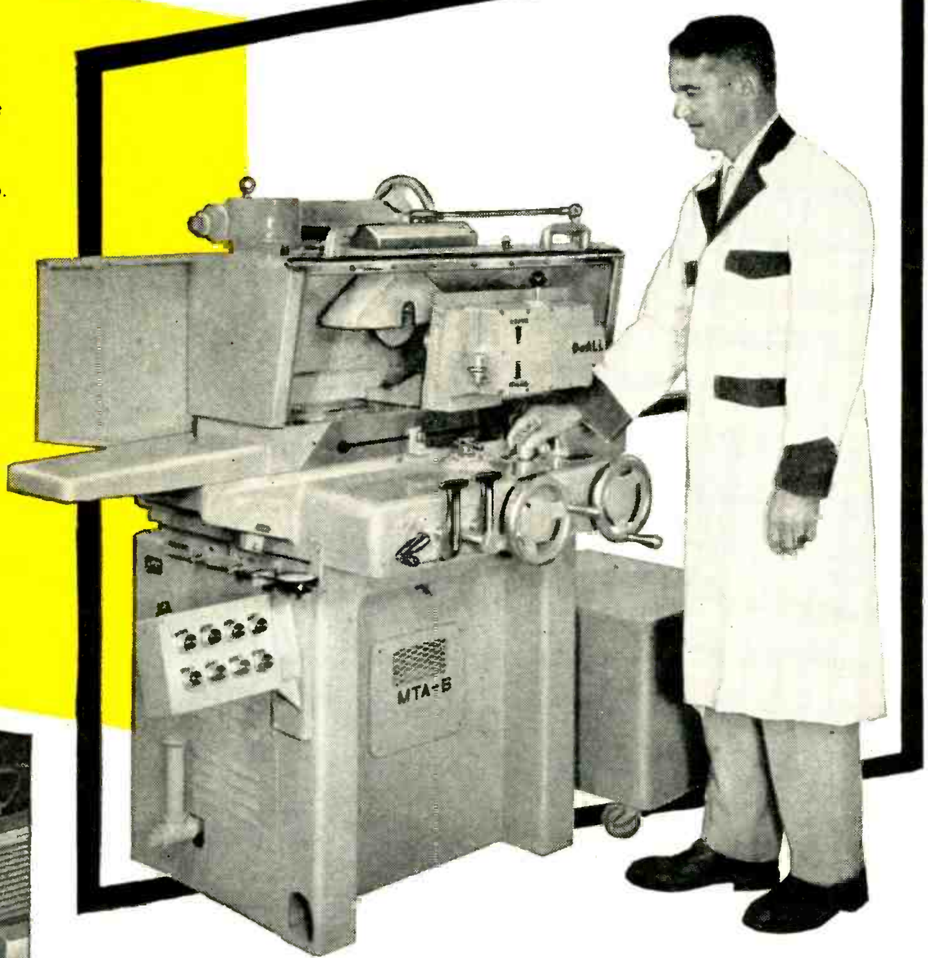

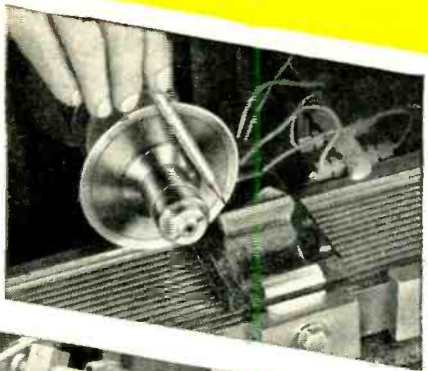

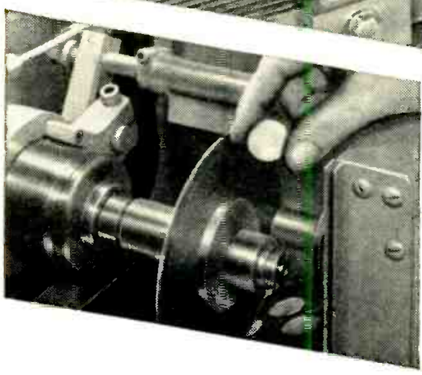

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GR-23

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ceiving tube manufacture. At the same time he did post-graduate work at MIT in vacuum tube design and metallurgy and in business administration at Harvard.

In 1941 Standing was employed by North American Phillips Co. and served as manager of its electronic tube division in Dobbs Ferry, N. Y., which produced power tubes and crt's. Six years later he joined Tung-Sol Electric Inc. serving in managerial capacities in their receiving tube plants, and later as manager of that firm's cathode-ray tube division. He rejoined Raytheon in 1954 to manage its cathode-ray tube division in Quincy, Mass.

Fenwall Hires Chief Engineer

New chief engineer of Fenwall Electronics, Inc., Framingham, Mass., is A. E. Lawson, Jr. (picture). In his new position Lawson will supervise the company's development work on thermistors—temperature sensitive semiconductors which have a large change in resistance for a small change in temperature. Among his activities will be work to extend the capabilities of thermistors beyond their present limits, and development of specialized designs for specific customer applications.

Lawson was formerly chief engineer of the Gow-Mac Instrument Co., and general manager of Davis Instruments. In the course of this work he acquired considerable experience with thermistors and their applications.

Name Tudbury Chief Engineer

New Rochelle Tool Corp., New Rochelle, N. Y., appoints Chester A. Tudbury (picture) to the post of chief engineer. The company manufactures h-f electronic devices for industry.

Tudbury comes to his new assignment from 16 years with the Ohio Crankshaft Co., where he was research engineer for the Tocco Division, specializing in h-f equipment. Prior to that he was engineering manager for the same company.

He was with the Induction Heating Division of the Budd Co., and has also been a professor of engineering at Wayne University in Detroit and at Fenn College in Cleveland.

B-W Promotes Teichmann

Appointment of Otmar E. Teichmann as associate director for engineering at Borg-Warner Center in Des Plaines, Ill., has been announced. He has been manager of products research in the engineering department of the Center since 1956. Previously he was manager of the heat-power research department and research advisor to the office of the assistant director at the Armour Research Foundation.

Austrian born Teichmann has had extensive experience in fluid mechanics, heat transfer, thermodynamics and electrical engineering. For several years he served on the teaching staff of the Illinois Institute of Technology.

GE Sets Up DEPDO

A DEFENSE planning and development operation (DEPDO) has been established in the defense electronics division of General Electric Co., Syracuse, N. Y. It was created to improve the integration of operations which will assist the division's product departments in meeting the expanding requirements of their customers.

DEPDO will bring together under one operation the following company components: a defense evaluation operation located in Washington, D. C.; the technical military planning operation at Santa Barbara, Calif.; the electronics laboratory at Syracuse; and the flight test operation at Schenectady, N. Y. A financial operation has been added to complete the organization. This component will have its headquarters at Syracuse.

Haywood S. Hansell (picture) is appointed manager of DEPDO. Hansell, who will maintain his office in Washington, D. C., was formerly manager, defense planning service, in the company's marketing services component. He held that position from May, 1955, when he joined GE, until his new appointment.

FTL Advances French

FEDERAL Telecommunication Laboratories, Nutley, N. J., research division of IT&T, names Heyward A. French an executive engineer.

Formerly a senior project engineer, French has participated in the development of radio communication equipment and systems since joining the Labs in 1943. He is co-inventor of the "parallel path" transmission technique used by both the Navy and commercial users to provide ultrareliable radio communication. Currently he is project manager in charge of the development of highly portable radio link equipment for use in combat areas by the Army Signal Corps.

Elect Putnam To Top Post

NEW president of G. M. Giannini & Co., Inc., Pasadena, Calif., is Donald H. Putnam (picture). He moves up from sales vice president to assume the position formerly held by Gabriel M. Giannini, board chairman.

Putnam joined the precision

control instrument firm in 1951 as executive assistant to the president and has held a variety of sales, engineering and production posts with the company here and in New York in his rise to the presidency. He has been an officer since 1952 and a director since May 1956.

His previous experience was with Sherman Fairchild & Associates, New York management and engineering consultants, and with the Applied Physics Laboratory of Johns Hopkins University, Silver Springs, Md.

RCA Promotes De Mooy

In his journey up the ladder, Harold A. De Mooy (picture) is now appointed manager, receiving tube operations, RCA Electron Tube Division, Harrison, N. J. He was previously manager, manufacturing, receiving for RCA receiving tube activities at Harrison and Woodbridge, N. J., Indianapolis, Ind., and Cincinnati, Ohio.

De Mooy joined the corporation in 1926 as an engineer and in 1932 was promoted to general foreman, quality control, at Harrison. From 1939 to 1947 he was successively manager, quality control; general foreman in the assembly of special purpose type tubes; and assistant superintendent in the same section. He was made superintendent of the miniature tube factory in 1947 and continued in that position until 1950 when he became manager of the Cincinnati plant. In February 1956 he was appointed manager, manufacturing, for receiving tube operations.

News of Reps

Components Division of IT&T Corp., Clifton, N. J., names **Don H. Burcham Co.**, Portland, Ore., its northwestern sales rep for semiconductor products. The Burcham Co. will handle sales of selenium rectifiers throughout Oregon, Washington, northern Idaho, northern Montana, Alaska and British Columbia.

Ling Electronics, Inc., Culver City, Calif., appoints **Ridgway Engineering, Inc.**, Chicago, Ill., as territorial sales reps for its full line of electronically-driven vibration testing systems and high power electronic equipment. Territory covered includes Indiana, Illinois, Wisconsin, western Kentucky and eastern Iowa.

Antenna and Radome Research Associates, Westbury, N. Y., appoints **H. L. Hoffman & Co.** as their reps in the northeastern states. Rep firm will present the complete line of ARRA microwave components, antennas and radomes for system and laboratory use.

The Electronics Division, Elgin National Watch Co., says the **John G. Twist Co.**, Chicago, Ill., will handle Advance and Elgin relay sales for the division in the Chicago, northern Illinois, southern Wisconsin and Michigan territories. Sales of American Microphone products, also manufactured by the division, will continue to be represented in these areas by the **A. H. Bruning Co.**, Chicago, Ill. Relay sales in the southern Illinois, Missouri, Kansas, Iowa and Nebraska areas will now be handled by the **E. W. McGrade Co.**, Kansas City, Mo.

Ward Leonard Electric Co., Mt. Vernon, N. Y., names **Martin-Rettger, Inc.**, Cleveland Heights, Ohio, as its sales rep for northern Ohio.

NEW BOOKS

The Electronic Musical Instrument Manual—3rd Ed.

By Alan Douglas
Pitman Publishing Company, New York, 1957, 247 p, $7.50.

The "Electronic Musical Instrument Manual" is a book aimed at describing, in some detail, the concepts involved in producing musical sounds via electrical and electronic means. The presentation is made in a smooth factual manner with sufficient information to permit the designer or hobbiest to delve further into the subject as desired.

The chapter devoted to sound, music and noise is conventional as related to the physics of the subject. The relation between the variout frequencies as a function of the fundamental, harmonics, transients and tempered scale is well outlined.

▶ **Tone Generation**—The production of tones via the use of electrical circuitry is complete in terms of electronic oscillators, electromechanical generators, reed and capacitor generators, photoelectronic synthesis and electrostatic generators. Mixing, filtering and keying is also well considered as a function of vacuum tube mixers and also as a mutual induction coupling process.

The section on amplifiers and loudspeakers is adequate and necessary for completeness of system coverage. Importance of the loudspeakers system is most critical to the proper rendering of tonal quality. The various types of distortion are described with suitable comments relative to ways and means for minimizing same.

Commercial electronic instruments are described beginning with the nondescript tone generator, the Thermine and going through the range of Trautonium, Solonox, Clavioline, Bode Melochord, Novachord, the German A. W. B. organ, the Minshall organ and the Electrochord. The Connsonata organ is described in some detail as relating to the application of more modern components. The Allen organ, the

Baldwin and the Constant-Martin are also described.

The Hammond Organ, one of the most widely known electronic instruments, is well presented with circuits and illustrations. Relatively new in the Hammond line, is the Chord Organ. This system is outlined relative to the different playing techniques as well as the method for generating and switching the chords and solo effects. Since the advent of the Chord Organ, there have been advances by Hammond in all spinet, home and church and concert models which are not discussed in the present edition. A percussion effect has been added which produces celesta-like tones with varying degrees of overtones and greater vibrato coupling has been developed.

The Baldwin, Wurlitzer, Welte and Compton Organs are also described.

A chapter is devoted to the presentation of experimental methods of tone production and should serve as stimulus to those interested in experimental research and development of unique new sounds.—G. E. HAMILTON, *American Broadcasting Company, New York, New York.*

THUMBNAIL REVIEWS

Control Engineering Manual. Edited by Byron K. Ledgerwood, McGraw-Hill Book Co., Inc., 1957, $7.50. Series of articles originally published in Control Engineering covering specifications, synthesis and evaluation of control systems; generating control functions; design techniques, analog computers and nonlinearity of control systems. An extensive bibliography is included.

Nuclear Power Engineering. By Genry C. Schwenk and Robert H. Shannon, McGraw-Hill Book Company, Inc., New York, 1957, 319 p, $6.50. This introductory book on the design, construction and operation of nuclear power plants also covers components of various systems, effects of irradation on equipment and health, plant location, economics and nuclear power, and other factors.

COMMENT

Wireless Microphone

Please clarify the following factors related to ("Wireless Microphone Uses F-M Modulation," Jan. 3, p 54).

Is the voltage of the battery shown in Fig. 1, 1.3 volts?

How is the induction field established externally with the transmitter tank enclosed in the metal housing shown in the photograph?

Is the 5-meter square loop laid in the horizontal plane?

How far away from this loop can a wireless-microphone equipped speaker stray before the receiver level drops below the rated 0.5-volt output?

MICHAEL BOZOIAN
ANN ARBOR, MICH.

The single mercury cell has a rated voltage of 1.35 volts. The metal shield for the transmitter is not complete; one side of the housing is formed by the phenolic wall on which the microphone is mounted, and the top and bottom of the housing are also phenolic sheet. Consequently there is no shorted turn surrounding the tank circuit, and the induction field is not interfered with by the housing.

The receiving loop is horizontal. It is installed under the moulding along the periphery of the lecture platform. Ordinarily, the speaker remains within the area of the loop, but the system continues to operate if the speaker moves no farther outside the loop than about two feet. At greater distances, the squelch operates to silence the receiver.

G. FRANKLIN MONTGOMERY
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WASHINGTON, D. C.

T-Pi Typos

In my paper "T and Pi Network Design" (Jan. 17, p 94) the following typographical errors appeared:

In line 5, col. 3, $B_n = -(AR$. . . etc., should be $B_\pi = -(AR$. . . etc.

In line 7 of the same column, the number appearing as 1,896 should be 1.896.

H. F. MATHIS
GOODYEAR AIRPORT CORP.
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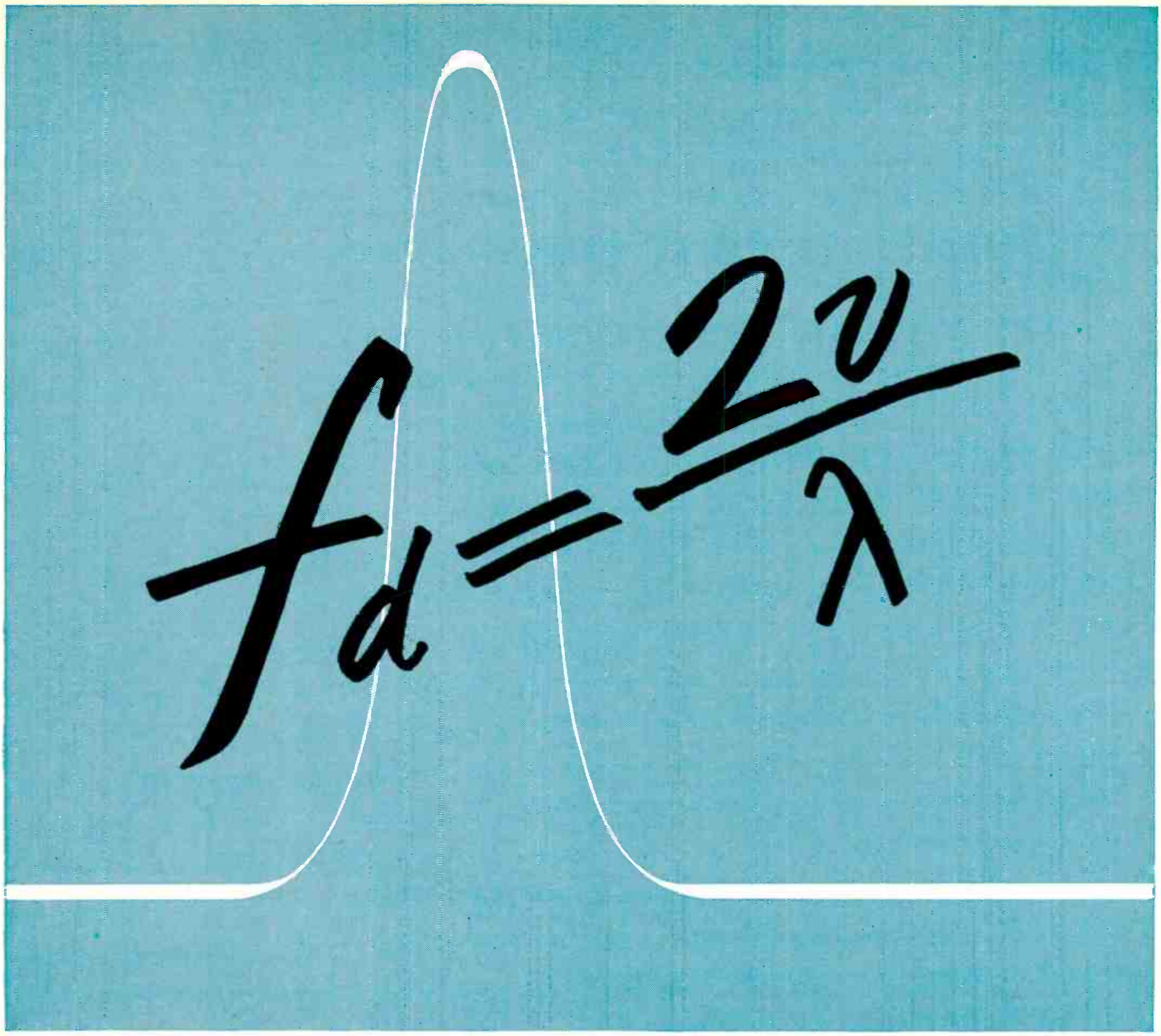

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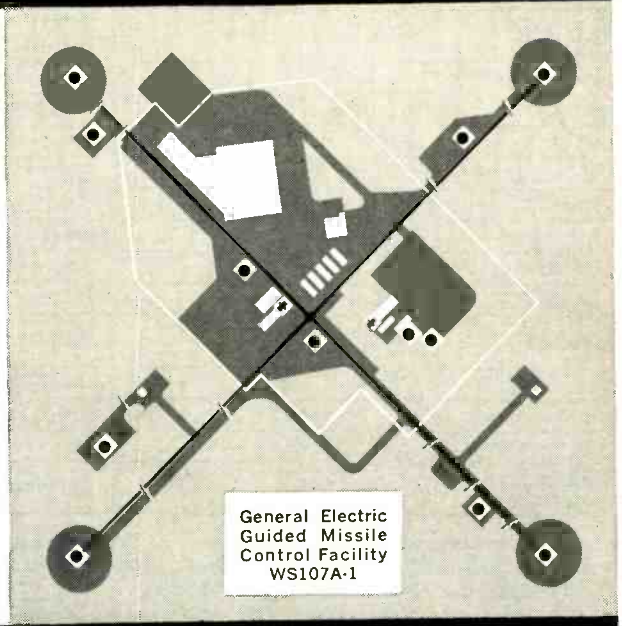

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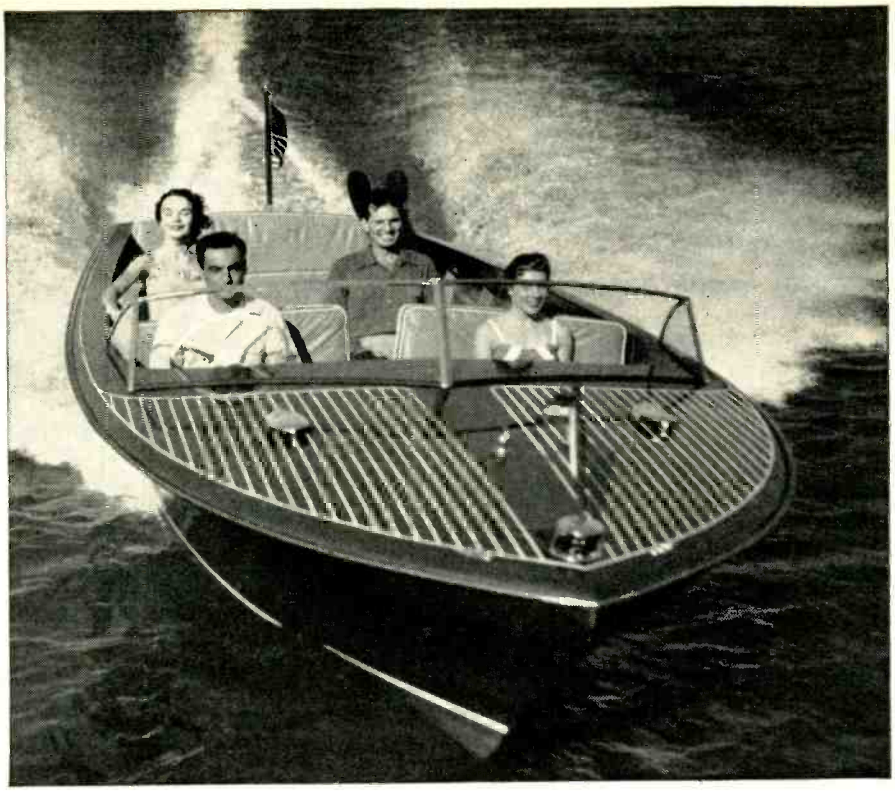

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BC-604 Transmitter 5.50	**DM-34** motors $2.75
FT-237 Mount 1.50	**DM-35** motors $8.50
BC-683 Receiver 15.00	**DM-36** motors $2.75
BC-684 Transmitter 10.50	**DM-37** motors $3.50
	BC-620 Rec-Trans $6.50

• • • • • • • • • • • • • • • • •

TALLEN CO., Inc.

159 CARLTON AVENUE
BROOKLYN 5, NEW YORK
TRiangle 5-8241

UNIVERSAL CONSOLE

Flexible—accommodates any standard RMA 19" rack mounted unit. The same unit may be installed in cabinets or consoles permitting flexibility in expansion or rearrangement.

The universal console is designed for operator comfort, viewing ease and maximum accessibility to all controls and chassis.

Two, three or more universal consoles may be ganged together. Thereby utilizing a minimum of space. Dimensions—Max. height: 57". Width: 19⅛". Distance floor to shelf: 27¾". Max. depth 37½". Weight: 150 lbs. approx.

COMPLETE UNIT *while they last*— $39.50

RED ARROW ELECTRONIC SALES CO.
1217 Summit Ave. Union City, N. J.

ENGINEERING DEGREES IN E.E.
Option Electronics or Power. May be earned by HOME STUDY or residence work.
(P.I.U. at present operating as a College of Engineering only.)

PACIFIC INTERNATIONAL UNIVERSITY
5719-G Santa Monica Blvd.
Hollywood 38, California

SPECIAL OFFERING

2° STEPPING MECHANISMS

—NEW—PN 8912A
Mfg. by Giannini & Co.

SAVE 90%

COST OVER $155. ea. OUR PRICE $15. ea.
H. Z. ROSENBERG & CO. 701 Seneca St.
WA. 4631 Buffalo 10, N. Y.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose receiving TV types, magnetrons, Klystrons, Broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: WAlker 5-7000
Barry, 512 Broadway, New York 12, N. Y.

If there is anything you want that other readers can supply
OR . . . something you don't want— that other readers can use—
Advertise it in the
SEARCHLIGHT SECTION

RELIABLE TUBES

C1B/A	$8.00	4E27	$8.00	SRU55A	$225.00	QK404	$65.00	5563	$25.00	5814WA	$3.25	6161	$55.00
C1K	7.50	4J52	55.00	V57	150.00	WE423A	7.50	5593	200.00	5817	125.00	6157	30.00
1P40	2.00	5ACP11	75.00	SRX92	250.00	WE428A	40.00	5607	475.00	5829WA	2.00	RK6177	150.00
1P41	1.50	5ADP7	35.00	QK103	50.00	575A	12.50	5626	40.00	5854	2.25	6189	3.00
2C39A	11.25	5AQP1	30.00	152TL	35.00	UE576	17.00	5641	4.50	5865	125.00	6214	30.00
2J36A	90.00	5FP4A	32.50	QK181	40.00	WL579B	15.00	5647	4.50	5902	4.50	RK6229	250.00
2J50	50.00	5J26	250.00	QK185	75.00	UE583	12.50	5650	70.00	5937	25.00	RK6230	350.00
2J51	175.00	5LP1	20.00	QK201	145.00	GL627	15.00	5651	1.25	5949	100.00	6282	100.00
2J56A	100.00	6AG5WA	2.25	QK202	145.00	GL672A	25.00	5702WA	4.00	RK5976	62.50	6292	45.00
2J70	100.00	6BL6	30.00	WE226A	100.00	721B	6.50	5703WA	3.50	RK5981	70.00	6316	100.00
2K25	17.50	6BM6	33.50	QK243	175.00	725A	50.00	RK5721	130.00	RK5982	125.00	6326	300.00
2K26	33.00	6BM6A	37.50	QK247	100.00	726C	15.00	5744WA	5.00	5987	15.00	6346	70.00
2K40	75.00	EL6B	7.00	WE261A	15.00	807—	1.50	5750	2.25	RK6037	175.00	6365	52.50
2K41	200.00	EL6CF	10.00	QK278	200.00	918	2.00	5751WA	3.00	6072	3.00	6383	75.00
2K45	35.00	6J21	475.00	EE300	16.50	CK1026	2.50	5764	40.00	6101	2.50	6414	5.00
2K48	55.00	SRC12	125.00	304TL	35.00	R1111	2.75	5768	30.00	6111	4.00	6587	35.00
2K50	175.00	8D21	1250.00	BL311	250.00	R1131C	10.00	RK5777	145.00	6112	4.00	6588	50.00
2K56	65.00	EL16B	15.00	BL315	50.00	R4340	15.00	RK5778	145.00	RK6115	60.00	6594	250.00
3JP7	7.50	KU23	12.50	WE339A	4.50	5527	110.00	5784WA	5.50	RK6115A	72.50	6655	42.50
4C33	125.00	KU42/6130	5.75	QK351	60.00	5545	20.00	5787	2.75	RK6116	140.00	6816	42.50
4D32	23.50	V45	450.00	WE353A	5.00	5550	25.00	5803	5.00	6152	7.00	6888	5.95

ALL mdse guaranteed. 24-hour telephones take your orders any time for prompt servicing. Material subject to prior sale.

PAGE ELECTRONICS

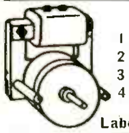
136 Liberty Street COrtlandt 7-4245 New York 6, N. Y.

KOILED CORDS 3 wires $1.26
22 inches long stretches to 9 ft.

GONIOMETERS—ONLY A FEW LEFT

WESTON PHOTRONIC CELL $4.50

PHOTO ELECTRIC Switch
Darkness throws the switch—turns lights on at dusk . . . off at dawn. Fools burglars who watch for signs of an empty house.
$10.94



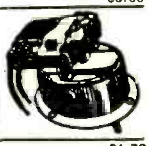
TELECHRON Motors

1 RPM	$3.95	3.6 RPM	$3.15
2 RPM	2.90	60 RPM	4.85
3 RPM	3.90	3 RPHr	2.85
4 RPM	3.90	1 RP 2Hr	2.80
		1 RP 12Hr	3.25

1 RPM—50 Cycles, $1.85
Laboratory Special 1 of Each Motor $25

D-E-L-A-Y-E-D A-C-T-I-O-N LIGHT SWITCH
Shuts light off automatically almost a minute later. Keeps porch or garage light on after you shut it off.
$3.50

6 Watt Most POWERFUL TELECHRON MOTOR
110 V. 60 Cy
1 RPM $6.50



HAYDON TIMING MOTORS

1 REV 4 Hours	$1.70
1 RPM 230v 60cy	1.00
1 RPM 110v 60cy	2.60
2 RPM 230v 60cy	1.00
30 RPM 110v 60cy	2.60
450 RPM, yes 450 RPM	1.30
HANSEN Synchron 4 RPM	4.24
CRAMER 4 RPM	4.65
1 REV. 90 min. 110v 60 cy	3.40
Laboratory Special 1 of Each Motor	$15

RELAY CONTACT BURNISHERS .59—2 for $1.00

PM MOTORS
Made by DELCO or DIEHL $3.75
Removed from equipment

BLAN
EST. 1923

INCLUDE POSTAGE
64 Y Dey St.
New York 7, N. Y.

SEARCHLIGHT SECTION

(Classified Advertising)

RATES
DISPLAYED

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.40 a line an insertion. BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

•PRE-SPRING INVENTORY CLEARANCE•

FEATURE ITEM
JEFFERSON STEP DOWN TRANSFORMER
4000 v primary, 120 v secondary 60 cycle ac, 500 watt
Original cost $68.00—Our price $15.00 each

CONDENSERS

10,000 F.P. plug in electrolitic

2000 mfd—15v	$15 per C
35x35 mfd—300v	20 per C
45x45 mfd—300v	25 per C
40x40x40 mfd—150v	20 per C
10x10 mfd—450v	20 per C

APC condensers, 3-25 .... $15 per C

Johnson, Oak, Hamm, 5-50 .... $20 per C

Hammarlund trans variable cond. 23 plates, 100 mfd, 2500 v ins, 1/4" shaft .... $1.00 ea.

5,000 C.R. barrel cond., 30 k, 500 mfd .... $35 per C

5,000 Johnson #160-107-18 midget variable condenser, 3 to 25 mfd, shaft 1"x1/4" .... $30 per C

Trimmers, Centralab or Erie, Type TS2A
3-12
4-30 $ 12.50 per 100
5-50 $100.00 per 1000

Oilfilled

10 mfd—600 v Upright	.90 ea.
4 mfd—600 v Upright	.35 ea.
2 mfd—600 v Side terminal type DYR	.35 ea.
4 mfd—1000 v Upright C.D.	$1.00 ea.
1 mfd—3000 v Upright	$1.50 ea.
16 mfd—660 v ac Upright #CPC482968	$3.00
3x5 mfd—600 v Bathtub	.20 ea.

Oilfilled, Bathtub type paper condensers side terminals, bottom or top—your choice

.05	mfd, 600 v	$10 per C
.05-.05	mfd. 600 v	15 per C
.05-.05-.05	mfd, 600 v	20 per C
.1	mfd, 600 v	15 per C
.1-.1	mfd, 600 v	20 per C
.1-.1-.1	mfd, 600 v	25 per C
.25	mfd, 600 v	15 per C
.25-.25	mfd, 600 v	25 per C
.25-.25-.25	mfd, 600 v	30 per C
.5	mfd, 600 v	20 per C
.5-.5	mfd, 600 v	25 per C
.5-.5	mfd, 600 v	30 per C
1.0	mfd, 600 v	20 per C
1.0-1.0	mfd, 600 v	30 per C

IMPORTED METERS

1 5/8" Square with Bakelite cases

S Meter (0 to 1 ma) (0 to 9 S units) +10 to +30 .... $5.00 ea.

VU Meter—20 to +3 and 0 to 100% .... $5.00 ea.

AC Volts, 0 to 15 volts or 0 to 150 volts .... $3.75 ea.

DV Volts, 0-15, 0-30, 0-200, 0-500 volts .... $3.75 ea.

DC Milliamps, 0-1, 0-100, 0-200, 0-500 ma .... $3.75 ea.

DC Microamps
0 to 50 va ... $6.00 ea.
0 to 100 va ... $5.50 ea.
0 to 200 va ... $5.50 ea.
0 to 500 va ... $5.00 ea.

SWITCHES

15,000 C. H., AN-3227-5, toggle switch 4 pole dt, 3 position, on-off & momentary bat handle .... .60

1000 C. H., AN-3023-5, toggle switch dpdt, on-off & momentary, bat handle ..... .40

5000 C. H., AN-3025-6, spst .... .40

1200 Square-D, #9320-962, large spst knife switch, antenna type, Hi-amps $1.50

5000 Gibbs switch box, SA-3A/A, AF33-(600)9373 Explosion switch, 11 to 13 gravities .... $1.00 ea.

RECTIFIER

5,000 Radio Receptor, 350 ma.. .60 each

TUBES

10,000	25Z6GT	$35 per C
5,000	6J4GT	40 per C
10,000	6SD7GT	25 per C
2,000	6SG7GT	20 per C
2,000	1U4GT	15 per C
10,000	VR-150	25 per C
5,000	6BA6	35 per C
5,000	12AT7	55 per C
200	4x150A Eimac	15.00 each
100	5J26 Raytheon	130.00 each

RESISTORS

20,000 10 watt, ww, 50-200-5000 ohm .05 ea

10,000 5 watt, ww, 400 ohm ...... .03 ea

10,000 2 watt control, ww, 300 ohm 1" shaft .... $10 per C

10,000 2 watt control, ww, 10,000 ohm, 1" shaft .... $10 per C

10,000 carbon pot., screwdriver shaft $50 per M

5,000 2 watt, carbon locknut, 500 K $15 per C

RCA GEIGER COUNTERS "FRACTION OF COST"

# 10A	$29.95
# 11A	34.95
# 12A	37.95
# 15A	99.95
# 16A	149.50

CIRCUIT BREAKERS

500 Heineman AM105 10M6, 2 amp —115 v ac .... each $1.00

5,000 Klixon, #C-6363, 15 or 30 amp. ea. .50

10,000 Klixon PDA20, spst, 60 cy ac each .40

10,000 Klixon PDA30, spst, 60 cy ac each .40

METERS

Westinghouse, 2 1/2" round, black face 0-5 MA $2.00

Triplett, 2 1/2" round, 0-35 MA $2.00

Hallicrafters, 2 1/2" round, 0-150 MA . $2.00

R. F. FILTERS

20,000 Tobe Filterettes
12A—Filterettes #1399 .... .50 ea
15A—Filterettes #1400 ..... .60 ea
75A—Filterettes DL-RF3-75 .60 ea

10,000 Astron RF Filterette .... .20 ea

RELAYS

Leach #6104, 115v ac, 30 amp contacts .... $3.00 ea.

Advance, 2000, 3 pole st, 39 ohm 6V dc cased relay .... $35 per C

TRANSFORMER

10,000 ouncer type transformer, 7/8" x 7/8" x 1 1/2", cased, mfg by Raytheon, Lionel-primary, 22 k ct, to 5200 ohm ct +600 ohm ct ... $35 per C

DISCOPHONE SALES CO, Inc

35 Vestry Street, New York 13, N. Y. WOrth 6-0512

Wire Or Call Collect—Samples On Request

INDEX TO ADVERTISERS

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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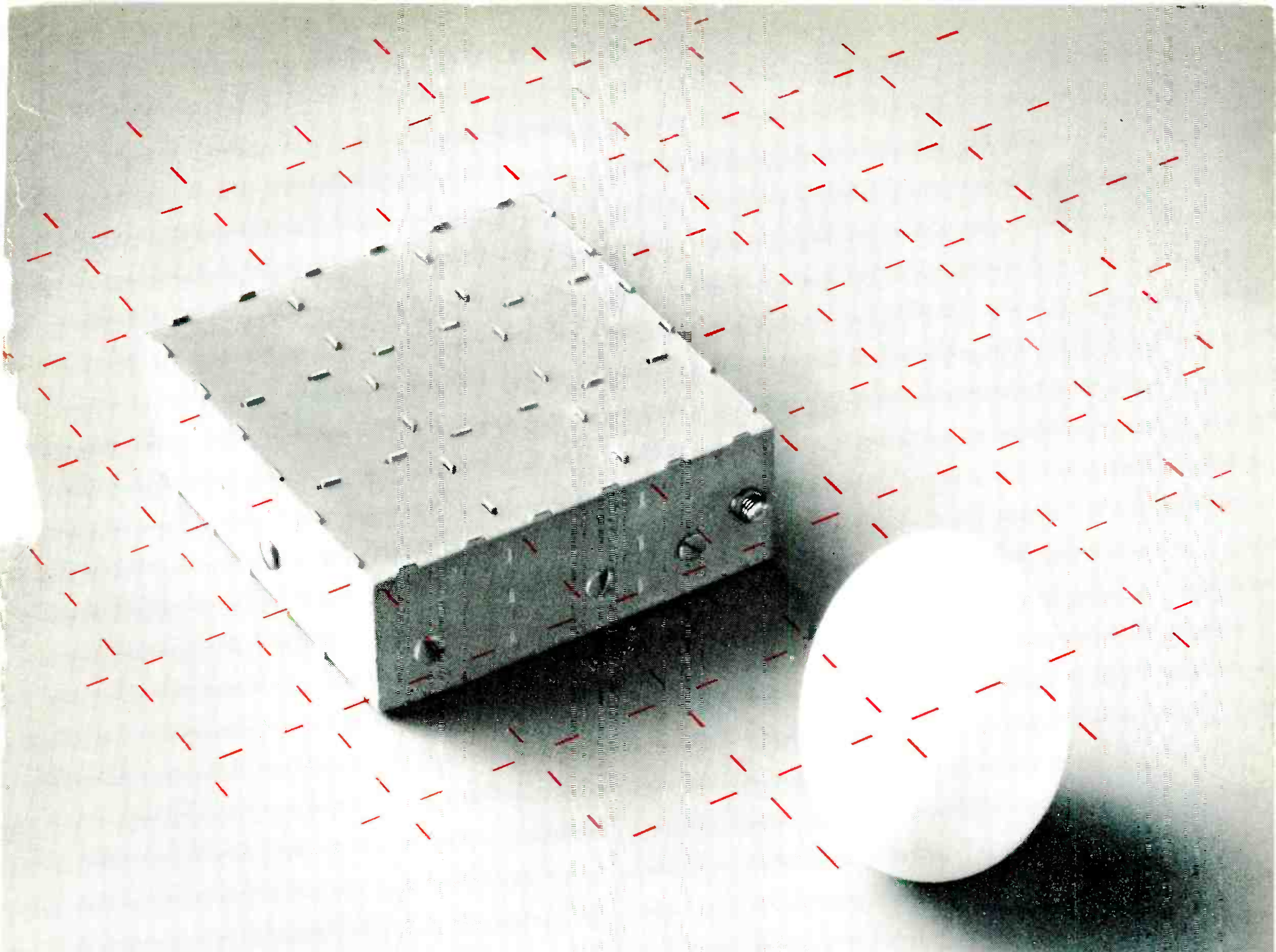

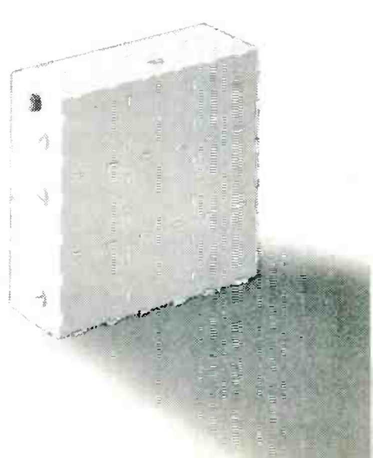

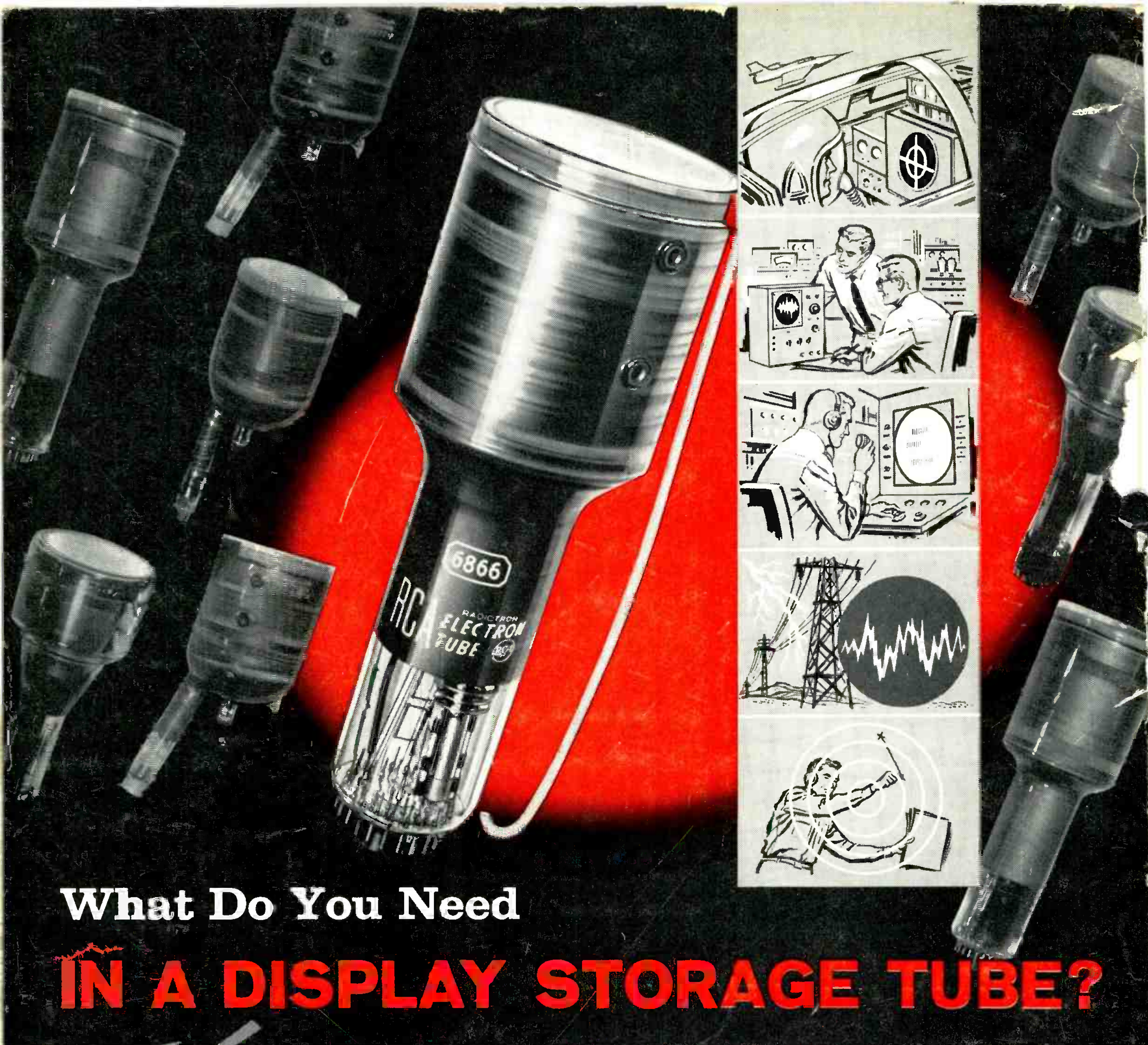

What Do You Need IN A DISPLAY STORAGE TUBE?

Display Brilliance
Half-Tone Display
Controllable Persistance
High Contrast
Fast Writing
Over-all Erase
Small-area Erase

That will depend, of course, on the specific requirements of your equipment design.

But whatever your need—whether the tube application is in airplane cockpit radar, analog computing, transient recording, fire-control radar, data transmission, or visual communication via narrow bandwidth transmission—look to RCA for expert design knowledge and manufacturing know-how on display storage tubes.

RCA Display Storage Tubes are already being supplied in quantity for many commercial and military applications. In addition, many developmental types of RCA Storage Tubes also are available to equipment manufacturers on a sampling basis. Ask your RCA Field Representative for complete details.

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Newark 2, N. J.
HUmboldt 5-3900

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Merchandise Mart Plaza
Chicago 54, Illinois
WHitehall 4-2900

6355 E. Wash. Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

GOVERNMENT SALES

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Harrison, N. J.
HUmboldt 5-3900

224 N. Wilkinson St.
Dayton 2, Ohio
BAldwin 6-2366

1625 "K" Street, N.W.
Washington, D.C.
DIstrict 7-1260

RADIO CORPORATION of AMERICA
Electron Tube Division — *Harrison, N. J.*