TELE-TECH
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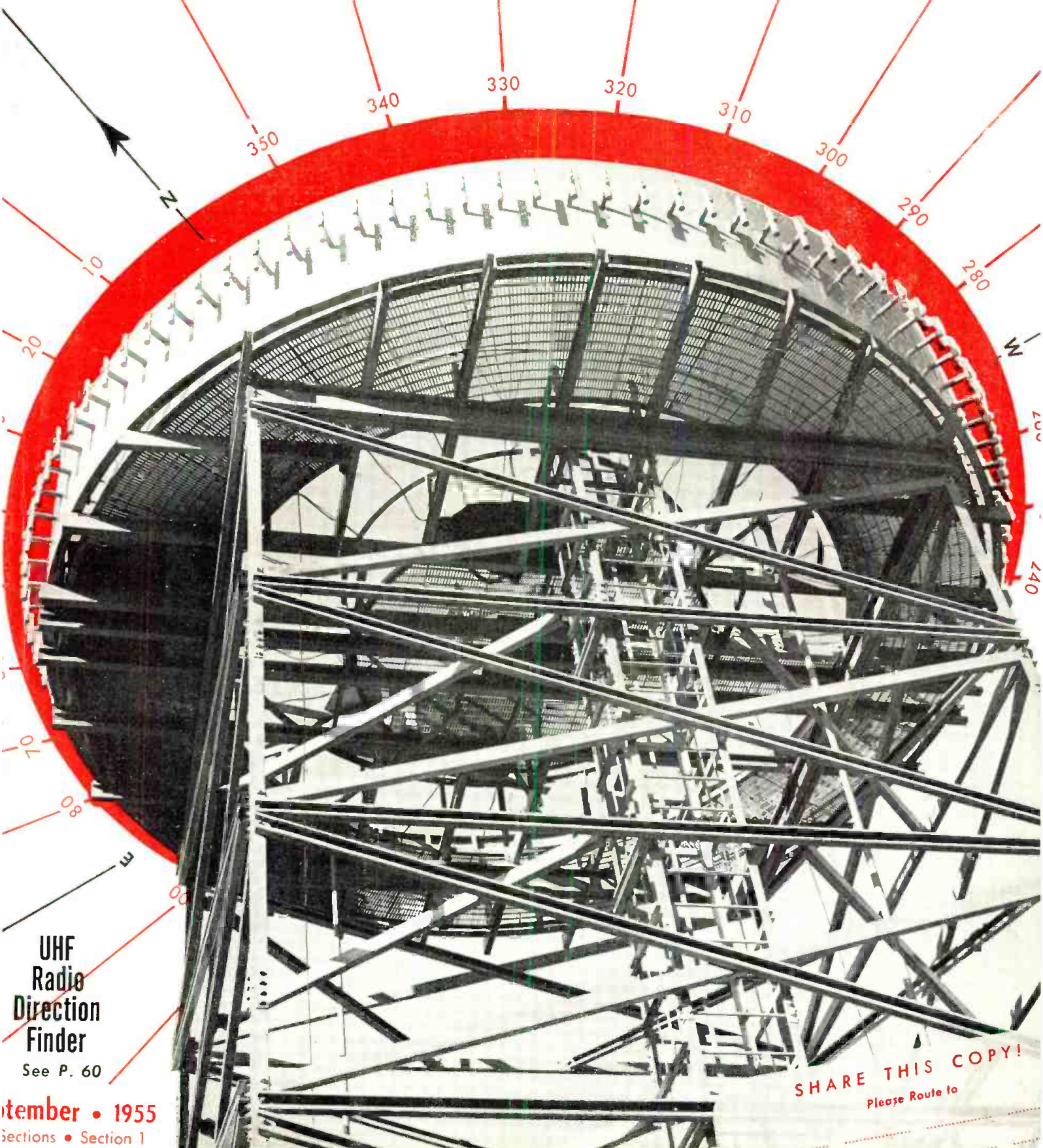

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Type JL stable capacity DISCAPS, as well as temperature compensating and by-pass types, are available with RMC "Wedg-loc" leads for printed circuit assemblies. The exclusive design of these leads lock securely in place on printed circuits . . . the capacitors cannot fall out and a uniform soldered connection is assured.

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To simplify production line problems on printed circuits Type JL DISCAPS, temperature compensating and by-pass types, are available with plug in leads. These leads are No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Plug-in DISCAPS will provide worthwhile savings on printed circuit assemblies and include all of the electrical and mechanical features that have made standard DISCAPS a favorite with leading television and electronic manufacturers.

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1955 TRANSISTOR SPECIFICATION CHART

Listed below by suggested application are technical characteristics for transistors now being commercially marketed. The data has been divided into five main categories to show those transistors having applications in audio circuits, video circuits, r-f and i-f circuits, computer and switching circuits and power circuits. Characteristics for transistors have been included in this tabulation. It should be pointed out, that this group contains non-RETMA registered types as well as registered RETMA type numbers. Note should also be taken of the fact that although RETMA transistor type registrations now total 137 not all of these types are currently being produced.

In presenting this data every effort has been made to retain as many as possible of the qualifying footnotes supplied by the various manufacturers. Where specifications were listed by the manufacturer for more than one circuit configuration in a single category the configuration most commonly used for that application is described.

TYPE NO.	CLASS (P-N-P, N-P-N, P-C)	C	PG (db)	PO (mw)	F_{co} (mc)	α or β	R_{in} (k Ω)	R_{out} (k Ω)	NF (db)	$T_{/max}$ °C	$T_{/op}$ °C	E_c TYP.	E_c MAX.	I_c (ma) TYP.	I_c (ma) MAX.	E_e	I_e	$P_{Diss.}$	S
FOR AUDIO APPLICATIONS																			
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.																			
OC70	P-N-P	GE			.3	30	2.20[a]	(b)	10	45	25	5	-10	.5	-10			25	H
OC71	P-N-P	GE			.3	47	.80[a]	(c)	10	45	25	5	-10	3	-10			25	H
(a) h_{11}; (b) Admittance h_{22} 23×10^{-6}; (c) Admittance 80 x 10^{-6}																			
CBS-HYTRON, Danvers, Mass.																			
2N36	P-N-P	GE	40			45	1.0	30		50	25	-6	-20	h	8		1	50	H
2N37	P-N-P	GE	36			30	1.0	30		50	25	-6	-20	i	8		1	50	H
2N38	P-N-P	GE	32			15	1.0	30		50	25	-6	-20	i	8		1	50	H
2N38[a]	P-N-P	GE	34[a]			18[b]	1.0	30	27[c]		25	-3	-20	0.5	8			50	H
2N80	P-N-P	GE				80	1.0[m]	500[n]		75	25	-6	-25	1.0	8/2[k]			50/20[k]	H
2N82	P-N-P	GE				20/60	2.5	80	25[f]	71[d]	25	-6	-20	1.0	15			35	H
2N116	P-N-P	GE	34[g]			18	1.0	30	27[c]			-3	-20	0.5	8			50	H
HA-1	P-N-P	GE	40			40	1.0	30	12[c]	50	25	-3	-20	0.5	8			50	H
HA-2	P-N-P	GE	37			30	1.0	30	27[c]	50	25	-3	-20	0.5	8			50	H
HA-3	P-N-P	GE		3.0[a]		35	1.0	1.2		50	25	-3	-20	2.5	12			50	H
HA-8	P-N-P	GE	40			40	1.0	30	12[c]	50	25	-3	-20	0.5	8			50	H
HA-9	P-N-P	GE	37			30	1.0	30	27[c]	50	25	-3	-20	0.5	8			50	H
HA-10	P-N-P	GE		3.0[a]		35	1.0	1.2		50	25	-3	-20	2.5	12			50	H
(a) R_L = 30,000, R_i = 1,000 (b) R_L = 3100, R_i = 100,000 (c) At freq. of 1000 CPS; R_L = 20,000, R_i = 1000 (d) Ambient temp. range -55 to 71°C (e) output admittance (f) in μ m hos V_c = -4.5 v, R_j = 6,000, R_L = 10,000 (g) minimum (h) Base current = 0.01 ma (i) Base current = 0.02 ma (j) Base current = 0.05 ma (k) @ 25°C/@ 75° C (l) @ 25°C (m) r_b (n) r_c (o) Minimum. I_c = 2.5 ma																			
FRETCO INC., 406 North Craig St., Pittsburgh 13, Pa.																			
2N34	P-N-P	GE	40			0.98	.50	30	50	60	30	-6	-25	-1	+8		+1 +8	50[a]	
2N35	N-P-N	GE	40			0.98	.50	30	50	60	30	+6	+25	+1	-8		-1 -8	50[a]	
2N36	P-N-P	GE	40			45	1.0	30	40	60	30	-6	-25	-1	+8		+1 +8	50[a]	
2N37	P-N-P	GE	36			30	1.0	30	40	60	30	-6	-25	-1	+8		+1 +8	50[a]	
2N38	P-N-P	GE	32			15	1.0	30	40	60	30	-6	-25	-1	+8		+1 +8	50[a]	
(a) at 30°																			
GENERAL ELECTRIC COMPANY, Tube Division, Schenectady, New York																			
2N43	P-N-P	GB	28	45		.98	60Ω	4.5	33	100	75	-5	-45		-50		5 50	150	
2N43A	P-N-P	GB	25	45		.98	10Ω	4.5	33	100	75	-20	-45				5 50	150	
2N44	P-N-P	GB	25	45		.955	10Ω	4.5	33	100	75	-20	-45		-50		5 50	150	
2N45	P-N-P	GB	23	45		.92	10Ω	4.5	33	100	75	-20	-45		-50		5 50	150	
2N76	P-N-P	GB	28			.99	55Ω	50		60	30	-5	-20		-10		1 10	50	
2N81	P-N-P					60	2.5		25	100			-20		15			50	
2N107	P-N-P	GB				.95	55Ω	50		60	30	-5	-12		-10		10		
GENERAL TRANSISTOR CORP., 95-18 Sutphin Blvd., Jamaica 35, N.Y.																			
GT-14	P-N-P	GE	36			28	.80	1500	16	85	25	-6	-25					70	H
GT-20	P-N-P	GE	40			45	.80	1500	16	85	25	-6	-25					70	H
GT-34	P-N-P	GE	32			15	.40	1000	16	85	25	-6	-25					70	H
GT-81	P-N-P	GE	42			65	1.0	2000	16	85	25	-6	-25					70	H
GT-24	P-N-P	GE	36			45	.80	1500	16	85	25	-1.5	-6					30	H
GT-81h	P-N-P	GE	42			90	1.0	2000	12	85	25	-1.5	-6					30	H
2N34	P-N-P	GE	40			40	0.5	30				-6	-25					70	H
2N36	P-N-P	GE	40			45	1.0	30				-6	-25					70	H
2N37	P-N-P	GE	36			30	1.0	30				-6	-25					70	H
2N38	P-N-P	GE	32			15	1.0	30				-6	-25					70	H
2N39	P-N-P	GE	39				0.5	30	24			-4.5	-30					50	H
2N40	P-N-P	GE	38				0.5	30	24			-4.5	-30					50	H
2N42	P-N-P	GE	36				0.5	30	24			-4.5	-45					50	H
2N44	P-N-P	GE	33		1.0		0.22	45	22			-20	-45					150	H

Key to Chart Symbols: C—circuit (GE—grounded emitter; GB—grounded base); PG (db)—power gain (db); PO (mow)—power output (milliwatts); F_{co} (MC)—Cutoff frequency; α or β—current amplification factor; α (less than unity), β, base current amplification factor (more than unity); R_{in}—input resistance (kilohms) unless otherwise indicated; R_{out}—output resistance (kilohms, unless otherwise indicated); NF (db)—noise factor; T_{max} (xx°C.)—maximum operating temperature; T_{op}—typical operating temperature; E_c—collector voltage; I_c—collector current; E_e—emitter voltage; I_e—emitter current; $P_{Diss.}$—Collector dissipation; S—Sealing (H—hermetic, S—solder); (P—plastic). Figures in E_c, I_c and E_e columns are (t) typical, and (r) max. values.

1955 TRANSISTOR SPECIFICATION CHART

TYPE NO.	CLASS (P-N-P, N-P-N, P-C)	C	PG (db)	PO (mw)	F_{co} (mc)	α or β	R_{in} (kΩ)	R_{out} (kΩ)	NF (db)	$T_{/max}$ °C	$T_{/op}$ °C	E_c TYP.	E_c MAX.	I_c (ma)	E_e	I_e	$P_{Diss.}$	S
GENERAL TRANSISTOR CORP. Continued																		
2N45	P-N-P	GE	30		1.0		0.125	45	22			-20	-22				150	H
2N63	P-N-P	GE	39		.8	22	0.8	20	25			-6	-22				33	H
2N64	P-N-P	GE	41		.8	45	1.5	20	22			-6	-22				33	H
2N65	P-N-P	GE	42		.8	90	2.7	20	20			-6	-25				33	H
GERMANIUM PRODUCTS CORP., 26 Cornelison Ave., Jersey City 4, N.J.																		
2N97	N-P-N	GE	38		1	15	.40	350	20	75	25	30		10		10	50	H
2N98	N-P-N	GE	47		2.5	40	.85	125	20	75	25	40		10		10	50	H
2N100	N-P-N	GE	53		5	140	3.5	35	20	50	25	25		5		5	25	H
2N103	N-P-N	GE	33		0.75	4	.225	1000	22	75	25	35		10		10	50	H
HYDRO-AIRE INC., 3000 Winona Ave., Burbank, Calif.																		
J-1	P-N-P	GB	40		1.0	0.97			11	55	25	-6	-40	-10		+1	150	H
J-2	P-N-P	GB	35		0.5	0.94			22	55	25	-6	-40	-10		+1	150	H
J-3	P-N-P	GB	30		0.5	0.90			33	55	25	-6	-40	-10		+1	150	H
HA-1	P-N-P	GB	40		1.0	0.975			10	55	25	-6	-20	-10		+1	100	H
CQ-1	P-N-P	GB	30		0.5	0.90			33	55	25	-6	-40	-10		+1	150	H
A-0	P-C	GB			3.0	2.0				55	25	-8	-20	+8		+0.3	50	H
A-1	P-C	GB			2.0	2.0				55	25	-8	-20	+8		+0.3	50	H
A-2	P-C	GB			1.0	2.0				55	25	-8	-20	+8		+0.3	50	H
A-3	P-C	GB			0.3	2.0				55	25	-8	-20	+8		+0.3	50	H
MINNEAPOLIS HONEYWELL REG. CO., TRANSISTOR DIV. 2753 Fourth Ave. So., Minneapolis 8, Minn.																		
H1	P-N-P	GB[g]	4	10000	.15	.935	5.5Ω	5		200[d]	160		-60	-800	±6 -30	1020	20000	H
H2	P-N-P	GB[g]	7	17500	.385	.98	3Ω	5		200[d]	130		-60	-1400	±5 -30	1600	20000	H
H3	P-N-P	GB[g]	6[a]	4400	.2	.95[b]	13Ω	10		200[d]	135[c]		-60	-350	±6 -30	450	5000	H
H4	P-N-P	GB[g]	7	6250	.3	.97	8Ω	10		200[d]	105		-60	-500	±5 -30	620	5000	H
2N57	P-N-P	GB[g]	5	12500	.2	.97	6Ω	5		200[d]	150		-60	-1000	±7 -30	1200	20000	H

(a) At a supply voltage of 30 v and operating to max. current. Power gain will increase 6db for a power output reduction of ½ caused by doubling the load resistance in the common base configuration. (b) Maximum value. (c) Value at maximum current. (d) Junction temperature. (e) Maximum mounting base temperature for this power output. (f) At a supply voltage of 30 v and operating to max. current. Power gain will increase more than 6db for a power output reduction of ½ caused by doubling the load resistance in the common emitter configuration. (g) Class B, push-pull.

PHILCO CORP., 4700 Wissahickon Ave., Phila. 29, Pa.																		
2N47	P-N-P	GE	40	25	1	.975	1	25	15	40	25	-5	-35	-1	-20		50	H
2N49	P-N-P	GE	40	25	1	.975	1	25	12	40	25	-5	-35	-1	-20		50	H
PHOTO-CRYSTALS, 15 S. 2nd St., Geneva, Illinois																		
	P-N-P	GE	36	70		18	.8	1500	12	85	50	-22	25	2				
RADIO CORP. OF AMERICA, Tube Division, Harrison, N.J.																		
2N77	P-N-P	GE	41			.013	.55	1.98	95	6.5	50[i]	25	-4	-25	-0.7	-15	0.7 15	35 H
2N104	P-N-P	GE	41			.0139	.44	1.05	68	12	70[i]	25	-6	-30	-1.0	50	1.0 50	150[h] H
2N105	P-N-P	GE	42			.014	.55	1.75	100	4.5	50[i]	25	-4	-25	-0.7	-15	0.7 15	35 H
2N109	P-N-P	GE[a]	33	160[b]			.70[c]	.375[d]	20[e]		50[i]	25	-9	-25	-13	-50	13 50	509 H

(a) Class B. (b) Total-Class B. (c) for large signal. (d) per base. (e) per collector. (f) operating temp. (g) per transistor (h) depending upon temp, and ckt parameters (i) operating.

RADIO RECEPTOR CO., INC. – has discontinued the manufacture of germanium transistors and diodes

RAYTHEON MFG. CO., RECEIVING & CATHODE RAY TUBE OPERATIONS, 55 Chapel St., Newton 58, Mass.																		
2N63	P-N-P	GE	39		0.6	22	.8	20	25	85	27	-6	-22		-10		1 10	100 H
2N64	P-N-P	GE	41		0.8	45	1.5	20	22	85	27	-6	-15		-10		1 10	100 H
2N65	P-N-P	GE	42		1.2	90	2.7	20	20	85	27	-6	-12		-10		1 10	100 H
2N106	P-N-P	GE	36		0.8	25	1.0	20	12	85	27	-2.5	-6		-10		0.5 10	100 H
CK721	P-N-P	GE	41		0.8	45	1.5	20	22	70	27	-6	-15		-10		1 10	172
CK722	P-N-P	GE	39		0.6	22	.8	20	25	70	27	-6	-22		-10		1 10	172
CK725	P-N-P	GE	42		1.2	90	2.7	20	20	70	27	-6	-12		-10		1 10	172
CK727	P-N-P	GE	36		0.8	25	1.0	20	12	70	27	-2.5	-6		-10		0.5 10	172
SPRAGUE ELECTRIC CO., 233 Marshall St., N. Adams, Mass.																		
Special	P-C	GB			75	72	.20–	30+	50–	70	25	15	50	1	10	1 5	1 10	80 H
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York, New York																		
2N34	P-N-P	GE	40			.6	40[a]	1.2	30	18	70	25	-6	-25	-1	-10		50 H
2N35	N-P-N	GE	40			.8	40[a]	1.2	30	16	70	25	+6	+25	+1	+10		50 H

(a) small signal h_{21}

TEXAS INSTRUMENTS INC., 6000 Lemmon Ave., Dallas 9, Texas																		
201	N-P-N	GE	40	2.3	1.1	19	.970	20	23[b]		50	5	30	-1	5			50[d] H
202	N-P-N	GE	43	2.38	1.3	49	1.25	20	20[b]		50	5	30	-1	5			50[d]
210	N-P-N		39	12[c]				10			50		30	2	5			50[d] H
300	P-N-P	GE				9	50		25[b]		50	-5	-30		-10		1	50[d] H
301	P-N-P	GE				19	50		20[b]		50	-5	-30		-10		1	50[d] H
X-2	N-P-N	GE[a]	22.7	500[a]	.225			1.0			50	22.5	35	40	75		1	100 H

(a) Push-pull, class B operation, (b) V_c = -2.5 V, (c) Distortion app. 6%, (d) at 25°C

I_e = 0.5 ma

TRANSISTOR PRODUCTS, 247 Crescent St., Waltham 54, Mass.																		
X-22	N-P-N					.9					25	40		5			50	H
X-23	N-P-N					.95					25	40		5			50	
OC-33	P-N-P	GB	29			.94					25	25		10		10	50	
OC-34	P-N-P	GB	29			.97					25	25		10		10	50	

Freq = 1 KC

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass.																		
2N34	P-N-P	GE	40			.8	40[b]	1.5	1000[a]	20	100	25-75		-25		-20	-6 +20	125 H
2N36	P-N-P	GE	40			.8	45	1.5	1000	20	100	25-75		-25		-20	-6 +20	125 H
2N37	P-N-P	GE	36			.6	30	1.2	1000	22	100	25-75		-25		-20	-6 +20	125 H
2N38	P-N-P	GE	32			.5	15	.6	1000	24	100	25-75		-25		-20	-6 +20	125 H
2N43	P-N-P	GE				.8	33	1.2	1000	20	100	25-75		-45		-50	-6 +50	150 H
2N44	P-N-P	GE				.5	16	.7	1000	22	100	25-75		-45		-50	-6 +50	150 H
2N45	P-N-P	GE				.4	9	.4	1000	22	100	25-75		-45		-50	-6 +50	150 H
2N63	P-N-P	GE				.5	20	.7	2000	18	100	25-75		-25		-20	-6 +20	125 H
2N64	P-N-P	GE				.7	30	1.2	2000	16	100	25-75		-25		-20	-6 +20	125 H
2N65	P-N-P	GE				1.2	50	1.8	2000	15	100	25-75		-25		-20	-6 +20	125 H
2N88[c]	P-N-P	GE	36			.5	25	1.7	2000	10	85	25-75		-12		-10	+10	25 H
2N89[c]	P-N-P	GE	36			.5	25	1.7	2000	20	85	25-75		-12		-10	+10	25 H
2N90[c]	P-N-P	GE	26			.5	40	1.2	.50	20	85	25-75		-12		-10	+10	25 H

(a) Output resistances are measured with the transistor connected in grounded-base fashion. (b) Values specified are minimum (c) Subminiature

Key to Chart Symbols: C—circuit (GE—grounded emitter; GB—grounded base); PG (db)—power gain (db); PO (mow)—power output (milliwatts); F_{co} (MC)—Cutoff frequency; α or β—current amplification factor; α (less than unity), β, base current amplification factor (more than unity); R_{in}—input resistance (kilohms) unless otherwise indicated; R_{out}—output resistance (kilohms, unless otherwise indicated); NF (db)—noise factor; T_{max} (xx°C.)—maximum operating temperature; T_{op}—typical operating temperature; E_c—collector voltage; I_c—collector current; E_e—emitter voltage; I_e—emitter current; $P_{diss.}$—Collector dissipation; S—Sealing (H—hermetic, S—solder); (P—plastic). Figures in E_c, I_c and E_e columns are (t) typical, and (r) max. values.

Here's the New

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SB

(Surface Barrier)

TRANSISTOR

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The Philco Surface Barrier Transistor operates efficiently with power consumption of less than *one* milliwatt! This extremely low power drain results in up to *ten* times the battery life obtainable with junction transistors, vastly reducing operating costs. Hermetically sealed, the SB Transistor has greater inherent characteristics of stability, longer life and higher efficiency than any other type of transistor.

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Now being produced in quantity this new Philco SB Transistor is available for your current projects and immediate shipment can be made to you.

For complete technical information on the PHILCO SB Transistor write Dept. TT

PHILCO CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

1955 TRANSISTOR SPECIFICATION CHART

TYPE NO.	CLASS (P-N-P, N-P-N, P-C)	C	PG (db)	PO (mw)	F_{co} (mc)	α or β	R_{in} (kΩ)	R_{out} (kΩ)	NF (db)	$T_{/max}$ °C	$T_{/op}$ °C	E_c TYP.	E_c MAX.	I_c (ma)	E_{c_1}	I_e	$P_{Diss.}$	S
TUNG-SOL ELECTRIC, INC., 95 Eighth Avenue, Newark, N.J.																		
DR-126	P-N-P	GE	33						14	85	25		-10			8	50	
DR-128	P-N-P	GE	26	2.5					18	85	25		-10			8	50	
DR-129	P-N-P	GE	35			.975			18	85	25		-25			8	50	
DR-130	P-N-P	GE	27			.930			21	85	25		-25			8	50	
DR-146	P-N-P	GE	27			.940				85	25		-25			8	50	
DR-154	P-N-P	GE	38			.992			18	95	25		-25			8	50	
WESTINGHOUSE ELECTRIC CORP., Electronic Tube Div., Elmira, N.Y.																		
2N54	P-N-P	GE	40		.50	.97	.50	50.0			25	-20	-45	-1	-10	-10	200	
2N55	P-N-P	GE	38		.50		.50	50.0			25	-20	-45	-7.5	-10	-10	200	
2N56	P-N-P	GE	38		.50		.50	50.0			25	-20	-45	-7.5	-10	-10	200	
2N71	P-N-P	GE	25		.40			.50				-25	-75	-40	-250		1000	
FOR VIDEO APPLICATIONS																		
GERMANIUM PRODUCTS CORP.																		
2N99	N-P-N	GE	47		3.5	40	.85	125	20	75	25	40			10	10	50	H
2N100	N-P-N	GE	53		5	140	3.5	35	20	50	25	25			5	5	25	H
3N23	N-P-N	GB[a]	12				.025	9	20	75	25	30			5	5	50	H
3N23A	N-P-N	GB[a]	14				.025	9	20	75	25	30			5	5	50	H
3N23B	N-P-N	GB[a]	15				.025	9	20	75	25	30			5	5	50	H
3N300C	N-P-N	GB[a]	17				.025	9	20	75	25	30			5	5	50	H
(a) f = 5 mc																		
PHILCO CORP.																		
SB-100		GE	30[a]		40[c]	95	1	20	15[b]	85[d]	25	-3	-4.5	-0.5	-5		10	H
L-5108		GE	35[a]		60[c]	95	1	20	15[b]	85[d]	25	-3	-4.5	-0.5	-5		10	H
(a) With 1 MC bandwidth and load and input impedance equal (b) lo-frequency average (c) this characteristic is not controlled directly; F_{max} is specified. F_{max} is 30-60 MC. SB-100, F_{max} is 60-80 MC, L-5108 (d) Storage																		
FOR RF-IF APPLICATIONS																		
FRETCO INC.																		
2N33P-C		GE	22	1[a]			.50	10	40	60	30	-8	-85	-3.3	-7	0.3 0.8	30	
(a) Useful $P/_{out}$ 40 MC																		
GENERAL ELECTRIC																		
2N78	N-P-N	GE				.95	1.5	10	20	100	30	5	15		20	-1 -20	50	
GENERAL TRANSISTOR CORP.																		
GT-760	P-N-P	GE	32		5	30				85	25	-6	-12				50	H
GT-761	P-N-P	GE	33		10	60				85	25	-6	-12				50	H
GT-762	P-N-P	GE			20	150				85	25	-3	-6				50	H
GERMANIUM PRODUCTS CORP.																		
2N97	N-P-N	GE[a]	20		1.0	15	.5	10	20	75	25	30			10	10	50	H
2N98	N-P-N	GE[a]	22		2.5	40	.5	10	20	75	25	40			10	10	50	H
2N99	N-P-N	GE[a]	22		3.5	40	.5	10	20	75	25	40			10	10	50	H
2N100	N-P-N	GE[a]	23		5	140	1.0	10	20	50	25	25			5	5	25	H
2N103	N-P-N	GE[a]	15		0.75	4	.25	10	20	75	25	35			10	10	50	H
(a) F = 455 kc, unneutralized																		
HYDRO-AIRE INC.																		
HF-1	P-N-P	GB	30		5.0	.96				55	25	-4.5	-12		-5		35	H
IF-1	P-N-P	GB			3.0	.96				55	25	-6	-12		-5		35	H
PHILCO CORP																		
SB-100		GE	33[a]		30-60[e]	.95	3.0	50	15[c]	85[d]	25	-3.0	-4.5	-.2	-5		10	H
L-5108		GB	18[b]		60-80[e]	.95	.4	1.5	15[c]	85[d]	25	-3.0	-4.5	-.2	-5		10	H
(a) Neutralized gain at 455 KC (b) Neutralized gain at 20 MC (c) Low-frequency average (d) storage (e) F_{max}																		
RAYTHEON MFG. CO.																		
2N112	P-N-P	GE	32		5	40	.6	25		85	27	-6	-6		-5	1 5	100	H
2N113	P-N-P	GE	33		10	45	.6	25		85	27	-6	-6		-5	1 5	100	H
2N114	P-N-P	GE	33		20	65				85	27	-6	-6		-5	1 5	100	H
SPRAGUE ELECTRIC CO.																		
Special	P-C	GB			10+	2+	500	30	50	70	25	15	50	1	10	1 5 1 10	80	H
SYLVANIA ELECTRIC PRODUCTS, INC.																		
2N94	N-P-N	GE	32		3	32	.5	25		70	25	+6	+20	+0.5	+10	-0.5 -10	50	H
2N94A	N-P-N	GE	35		6	32	.8	25		70	25	+6	+20	+0.5	+10	-0.5 -10	50	H
"Data given is for operation in a tuned, neutralized 456 KC i-f amplifier stage."																		
TEXAS INSTRUMENTS INC.																		
220	N-P-N		33				.75	70			50	22.5	30	0.7	5		50	H
223	N-P-N		60[a]				.30	60			50	22.5	30	0.7	5		50	H
(a) Conversion gain. 220-for 262 KC i-f. 233-Combined osc.-mixer																		
TUNG-SOL ELECTRIC INC.																		
DR-151	P-N-P	GB			5.0	.970	28	500		85	25		-10			8	50	S
DR-152	P-N-P	GB			10.0	.970				85	25		-10			8	50	S
DR-155	P-N-P	GB			1.4	.970				85	25		-10			8	50	S
FOR COMPUTER & SWITCHING APPLICATIONS																		
CBS HYTRON																		
HC-1	P-N-P	GE	40		0.7	45	1.0	30		50	25	-6	-20	0.01	8	1	50	H
FRETCO INC.																		
2N32	P-C	GE	21	1		2.2	.2	31	40	60	30	-25	-40		-8	0.5 3	50[a]	
(a) @ 30°C																		
GENERAL TRANSISTOR CORP.																		
GT-83	P-N-P	GE	40		0.7	45	.8	1500		85	25	-15	-25					H
GT-87	P-N-P	GE	36		0.5	28	.8	1500		85	25	-15	-25					H
GT-88	P-N-P	GE	42		1.0	65	1.0	2000		85	25	-15	-25					H
GT-122	P-N-P	GE	42		2.0	90	1.5	2500		85	25	-15	-25					H
GERMANIUM PRODUCTS CORP.																		
2N97	N-P-N	GB			1.0													
2N98	N-P-N	BB			2.5													
2N99	N-P-N	GB			3.5													
2N100	N-P-N	GB			5													
For 2N98, 2N99, 2N100 rise/time .2– μ sec.																		
For 2N97 - rise time = 2- μ sec.																		

Key to Chart Symbols: C—circuit (GE—grounded emitter; GB—grounded base); PG (db)—power gain (db); PO (mow)—power output (milliwatts); F_{co} (MC)—Cutoff frequency; α or β—current amplification factor; α (less than unity), β, base current amplification factor (more than unity); R_{in}—input resistance (kilohms) unless otherwise indicated; R_{out}—output resistance (kilohms, unless otherwise indicated); NF (db)—noise factor; T_{max} (xx°C.)—maximum operating temperature; T_{op}—typical operating temperature; E_c—collector voltage; I_c—collector current; E_e—emitter voltage; I_e—emitter current; $P_{diss.}$—Collector dissipation; S—Sealing (H—hermetic, S—solder); (P—plastic). Figures in E_c, I_c and E_e columns are (l) typical, and (r) max. values.

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- Greatly improved noise figure over previous types.
- Reversible for use in balanced mixer circuits.
- 20° higher range in ambient operating temperatures.
- Controlled processing . . . rigid testing assures uniform diode characteristics . . .

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In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

1955 TRANSISTOR SPECIFICATION CHART

TYPE NO.	CLASS (P-N-P, N-P-N, P-C)	C	PG (db)	PO (mw)	F_{co} (mc)	α or β	R_{in} (kΩ)	R_{out} (kΩ)	NF (db)	$T_{/max}$ °C	$T_{/op}$ °C	E_c TYP.	E_c MAX.	I_c (ma)	E_{e}		I_c	$P_{/Diss}$	S
HYDRO-AIRE INC.																			
S-0	P-C	GB								55	26		-40		+8			50	H
S-1	P-C	GB								55	26		-40		+8			50	H
S-2	P-C	GB								55	26		-30		+8			50	H
MINNEAPOLIS HONEYWELL REG. CO.																			
H1	P-N-P	GE[g]	12	10,000	.02	14	3.5	25Ω	.500	200[d]	160		-60	-800	±6	-30	1020	20000	H
H2	P-N-P	GE[g]	16	17500	.02	54	8	25Ω	.500	200[d]	130		-60	-1400	±5	-30	1600	20000	H
H3	P-N-P	GE[g]	12[f]	4400	.02	18[b]	3[c]	60Ω	1.0	200[d]	135		-60	-350	±6	-30	450	5000	H
H4	P-N-P	GE[g]	14	6250	.02	35	6	40Ω	1.0	200[d]	105		-60	-500	±5	-30	620	5000	H
2N57	P-N-P	GE[g]	13	12500	.02	28	5	40Ω	.500	200[d]	150		-60	-1000	±7	-30	1200	20000	H

(b) Maximum value, (c) Value at maximum current (d) Junction Temperature (e) Maximum mounting base temperature for this power output. (f) At a supply voltage of 30 v and operating to max. current. Power gain will increase more than 6 db for a power output reduction of 1/2 caused by doubling the load resistance in the common emitter configuration. (g) Class B, push-pull

SPRAGUE ELECTRIC CO.																			
5A	P-C	GB			2+		2+	200+	30+	50-	70	25	15	50	1	10	1	5	1	10	80	H
SYLVANIA ELECTRIC PRODUCTS, INC.																			
2N34	P-N-P	GE	30	200					2.2		70	25	-22.5	-25					
2N35	N-P-N	GE	Same as 2N34 except for reversed polarities.								70	25							
2N68	P-N-P	GE	17	12000					12Ω		70	25	-12	-30					
2N94	N-P-N	GE	25	100					1.2		70	25	+12	+20					
2N94A	N-P-N	GE	25	100					1.2		70	25	+12	+20					
2N95	N-P-N	GE	Same as 2N68 except for reversed polarities.																
2N101	P-N-P	GE	Same as 2N68 except for reduced dissipation Ratings																
2N102	N-P-N	GE	Same as 2N101 except for reversed polarities.																

(a) Collector dissipation for the 2N68 and 2N95 operated in free air is 2.5 watts. When attached to a heat sink (25 sq. in. of 1/16" aluminum minimum per transistor) dissipation is 4 watts per transistor. (b) Collector dissipation for the 2N101 and 2N102 operated in free air is 1 watt. When attached to a heat sink (25 sq. in. of 1/16" aluminum minimum per transistor) dissipation is 4 watts per transistor.

TRANSISTOR PRODUCTS																			
2A	P-C		22			1.5						50	8					120	
2C	P-C					2						50	8					100	
2D	P-C		22		2	1.5						50	8					100	
2E	P-C		22		10	1.5						50	8					100	
2G	P-C					2						50	8					120	
2H	P-C		22			2						50	8					100	
2N32	P-C		21		2.7	2.2						40	8					50	
2N33	P-C		22		3	2.3						8.5	7					30	
2N50	P-C		22		3	2						15	1					50	
2N51	P-C					2.2						50	8					100	
2N52	P-C		22		1	1.5						50	8					120	
2N53	P-C				5	2						50	8					120	
TRANSITRON ELECTRONIC CORPORATION																			
2N91[a]	P-N-P	GE		1500	b	25	70	500		85	25 to 75	-15	-500		-6		+500	500	H
2N92[a]	P-N-P	GE		500	c	30	.6	1000		85	25 to 75	-25	-200		-6		+200	125	H

(a) Switching-type unit (b) Rise Time = μ sec. max.; (c) Delay Plus Rise Time = 2.5 μ sec. max.;

WESTINGHOUSE ELECTRIC CORP.																			
2N73	P-N-P	GE	for low frequency switching									-20						200	
2N74	P-N-P	GE	for low frequency switching									-50						200	
2N75	P-N-P	GE	for low frequency switching									-20						200	

FOR POWER APPLICATIONS

AMPEREX ELECTRONIC CORP.																			
2-0C72	P-N-P	GE	27	200[b]	.010	25				60	45	6.0	6.5	110[c]	-110			50	

(a) Push-pull, 2 transistors

CBS-HYTRON																			
2N108	P-N-P	GE[a]		35			1500	400				-3.5	-20	(b)	15	-0.125		50	H

(a) Class B, push-pull (b) I_c zero signal = 6 ma; I_c max. signal = 21 ma (c) @ 25°C Vin = 3.5 V rms

HYDRO-AIRE INC.																			
JP-1	P-N-P	GB	15	350					15	50	25	-22.5	-45		-100		+20	500	H
MINNEAPOLIS HONEYWELL REG. CO.																			
H3	P-N-P	GE[g]	12[f]	4400	.02	18[b]	3[c]	60Ω	1.0		200[d]	135[e]		-60	-350	±6	-30	450	5000	H
H4	P-N-P	GE[g]	14	6250	.02	35	6	40Ω	1.0		200[d]	105		-60	-500	±5	-30	620	5000	H
H1	P-N-P	GE[g]	12	10000	.02	14	3.5	25Ω			200[d]	160		-60	-800	±6	-30	1020	20000	H
2N57	P-N-P	GE[g]	13	12500	.02	28	5	40Ω			200[d]	150		-60	-1000	±7	-30	1200	20000	H
H2	P-N-P	GE[g]	16	17500	.02	54	8	25Ω			200[d]	130		-60	-1400	±5	-30	1600	20000	H

(b) Maximum value (c) Value at maximum current (d) Junction Temperature (e) Maximum mounting base temperature for this power output. (f) At a supply voltage of 30 v and operating to max. current. Power gain will increase more than 6db for a power output reduction of 1/2 caused by doubling the load resistance in the common emitter configuration. (g) Class B-push-pull

SYLVANIA ELECTRIC PRODUCTS, INC.																			
2N68	P-N-P	GE	23	600	.4		40	75Ω	100		70	25	-12	-30	-150	-1500	150	1500	(a)	H
2N95	N-P-N	Same as 2N68 except for reversed polarities																		H
2N101	P-N-P	Same as 2N68 except for reduced collector dissipation when operated in air.																	(b)	H
2N102	N-P-N	Same as 2N95 except for reduced collector dissipation when operated in air.																	(b)	H

(Collector dissipation for the 2N68 and 2N95 operated in free air is 2.5 watts. When attached to a heat sink (25 sq. in. of 1/16" aluminum minimum per transistor) dissipation is 4 watts per transistor. (b) Collector dissipation for the 2N101 and 2N102 operated in free air is 1 watt. When attached to a heat sink (25 sq. in. of 1/16" aluminum minimum per transistor) dissipation is 4 watts per transistor.

TRANSISTOR PRODUCTS																			
X102	P-N-P		10		.01	.9					75	25	100		1.0 A			.250W	
X107	P-N-P	GB	23	1000			1.5	375			75	25	60		1.0 A			2.25W	
X120	P-N-P	GB	18	5300			.8	70			75	25	60		4.0 A			15W	
X122	P-N-P	GB	22	2800			.9	150			75	25	60		4.0 A			7.5W	
X125	P-N-P	GB					1.5	375			75	25	60		1.0 A			1.2W	
TRANSITRON ELECTRONIC CORPORATION																			
2N83	P-N-P	GE	30	2500[a]	.4	8[b]		12Ω	.02Ω		100	25	75	-60	-1000	-6	+1000	10,000	H
2N84	P-N-P	GE	32	2000	.4	12[c]		16Ω	.02Ω		100	25	75	-45	-1000	-6	+1000	10,000	H
2N85	P-N-P	GE	30		.8	40		.60	.16Ω	20	100	25	75	-45	-100	-6	+100	750	H
2N86	P-N-P	GE	26		.8	20		.40	.125Ω	20	100	25	75	-60	-100	-6	+100	750	H
2N87	P-N-P	GE	26		.8	20		.40	.125Ω	20	100	25	75	-30	-100	-6	+100	750	H

(a) Push-pull (b) @ 200 ma I_c (c) @ 300 ma I_c (d) connected in grounded-base fashion

TUNG-SOL ELECTRIC INC.																			
DR-150	P-N-P	GB			0.25	.970	8Ω		.030		85	25		-25			8	5000	S

Key to Chart Symbols: C—circuit (GE—grounded emitter; GB—grounded base); PG (db)—power gain (db); PO (mow)—power output (milliwatts); F_{co} (MC)—Cutoff frequency; α or β—current amplification factor; α (less than unity), β, base current amplification factor (more than unity); R_{in}—mput resistance (kilohms) unless otherwise indicated; R_{out}—output resistance (kilohms, unless otherwise indicated); NF (db)—noise factor; T_{max} (xx°C.)—maximum operating temperature; T_{op}—typical operating temperature; E_c—collector voltage; I_c—collector current; E_e—emitter voltage; I_e—emitter current; $P_{diss.}$—Collector dissipation; S—Sealing (H—hermetic, S—solder); (P—plastic). Figures in E_c, I_c and E_e columns are (t) typical, and (r) max. values.

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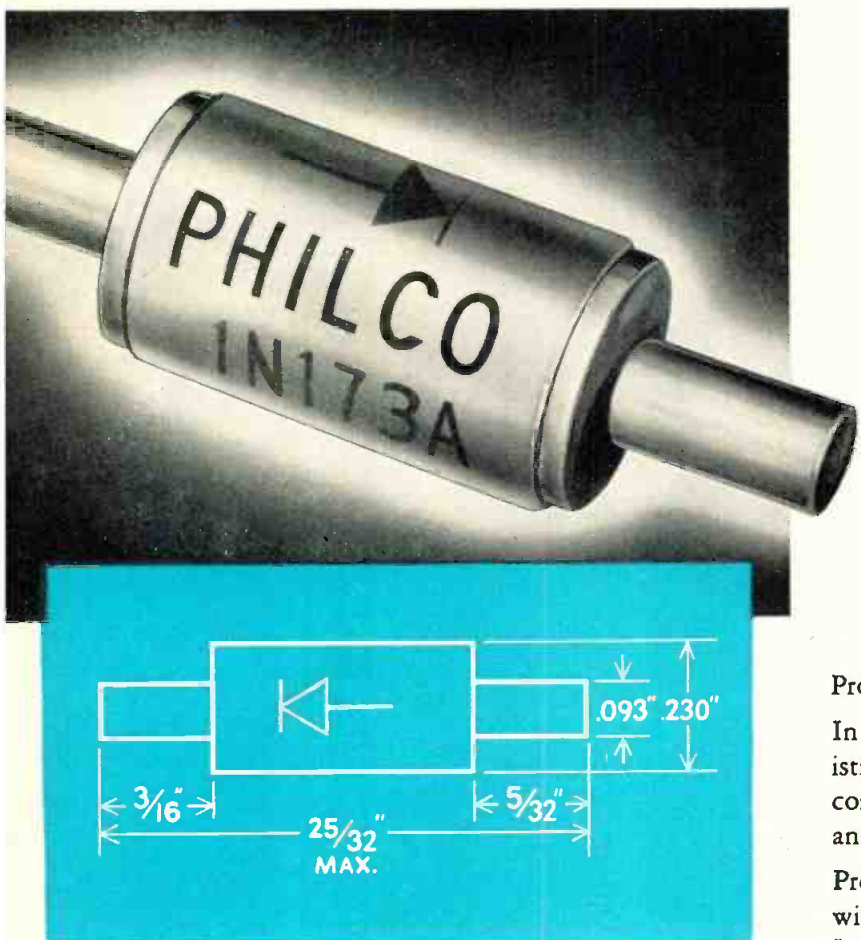

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TELE-TECH & Electronic Industries

SEPTEMBER, 1955

FRONT COVER: This striking array is the Radio Direction Finder AN/GRD-9 installed at the Rome Air Development Center, Rome, N. Y. The system employs the Wullenweber technique which was conceived and exploited under the direction of the German Naval Ministry during WW II. Details of US system design begin on page 60 in this issue.

SECTION ONE:

DEPARTMENTS

SECTION TWO: 1955 Transistor Specification Chart

TELE-TECH & ELECTRONIC INDUSTRIES, September 1955, Vol. 14, No. 9. Published monthly by Caldwell-Clements, Inc. Publishers also of MART and TECHNICIAN. Publication Office, Emmett St., Bristol, Conn. Editorial, advertising and executive offices, 480 Lexington Avenue, New York 17. Telephone PLaza 9-7880. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Treasurer; M. B. Clements, Secretary. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. Additional acceptance at New York, N. Y. 75¢ a copy. Subscription Rates: United States and U. S. Possessions: 1 year $5.00; 2 years $8.00; 3 years $10.00. Conoda: 1 year $7.00; 2 years $11.00; 3 years $14.00. All other countries: 1 year $10.00; 2 years $16.00. Please give title, position and company connections when subscribing.

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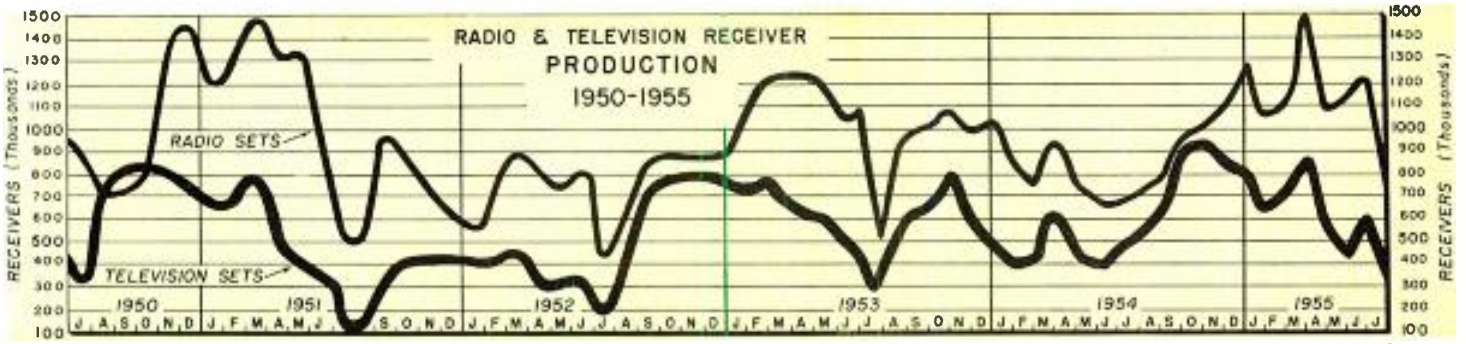
FIRST IN TOROIDS AND RELATED NETWORKS



West German Electronic Production

Following 1954 production figures provided through the German Radio, TV and Phono Exhibition in Dusseldorf:

Radio receivers	2,841,000
Television receivers	19,023
Phonograph records	24,000,000

Broadcast Stations in U. S.

	AM	FM	TV		
Stations on Air	2719	499	331 106	UHF UHF	Comml
			7 3	VHF UHF	Educ
Under Construction (CPs)	160	54	54 105	VHF UHF	Comml
			7 14	VHF UHF	Educ
Applications	209	11	141 16	VHF UHF	Comml

Color TV

From the 13th semi-annual Tele-Census Report (3259 Wilshire Blvd., Los Angeles 5, Calif.)

What would induce you to buy a color-TV set now?

Lower Prices	55.4%
More Color Programs	8.4%
Nothing or not interested	25.9%
Other answers	10.3%

Radio-TV Production

RETMA has released the following production figures for the first half of 1955:

	Television	Home Sets	Portables	Auto	Clock	Total Radios
January	654,582	280,121	47,303	573,837	166,885	1,068,146
February	702,514	232,831	109,120	597,742	150,031	1,089,724
March (5 weeks)	831,156	300,840	233,465	774,025	173,944	1,482,274
April	583,174	193,431	265,866	567,876	72,602	1,099,775
May	467,394	161,357	258,701	563,369	130,608	1,114,035
June (5 weeks)	589,973	181,930	255,833	584,567	182,605	1,204,935
Total	3,828,793	1,350,510	1,170,288	3,661,416	876,675	7,058,889

Tube Production

RETMA has released the following figures on sales of picture and receiving tubes during the first half of 1955:

	Picture Tubes		Receiving Tubes	
	Units	$ Value	Units	$ Value
January	866,956	17,661,018	37,949,762	26,877,457
February	859,529	17,119,568	38,526,796	28,107,186
March (5 wk)	913,003	17,625,881	40,859,562	29,742,529
April	788,317	14,620,075	35,426,153	26,779,586
May	779,329	14,572,518	32,920,310	25,914,821
June (5 wk)	706,890	13,244,499	40,819,961	31,254,324
	4,914,024	$94,893,559	226,502,544	$168,675,903

Germanium Diode Sales—1955

Estimated sales of point contact germanium diodes during the first half of 1955 are as follows:

	Equip. Mftrs.	Renewal
Entertainment Appl.	3,327,200	306,700
Non Entert. Appl.	5,858,300	758,200
Total	9,185,500	1,064,900
Grand Total	10,190,400	

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in July 1955.

Actuators	312,667	Generators	1,824,052	Rectifiers	225,106
Adapters	427,714	Generators, Signal	635,216	Relays	87,686
Air Speed Indicators	105,564	Heat Sealing Machines	234,217	Simulators, Beacon	1,042,134
Amplifiers	4,478,675	Indicators	945,618	Sound Ranging Sets	910,280
Antennas	261,555	Indicators, Tachometer	85,687	Spectrum Analyzer	412,453
Antenna Kits	195,167	Induction Heating Equipt.	31,043	Step Poles	215,950
Batteries	497,609	Inverters	34,519	Switches, Thermostatic Control	249,846
Battery Chargers	109,967	Meters	256,596	Switches, Toggle	117,360
Beacons, Radio	258,484	Meters, Amplitude Modul.	81,403	Telegraph Repeater Units	138,317
Cable	2,564,252	Multimeters	42,117	Telegraph Terminal, Transistorized	126,728
Cable Ass'ys	151,082	Multiplexer Sets	45,397	Telephone Sets	465,046
Capacitors	78,723	Oscilloscopes	61,523	Test Equipment	382,957
Clamps, Electrical	34,193	Phase Adapters	682,752	Test Leads	82,922
Code Practice Equipt.	67,382	Positioning Mechanisms	46,417	Test Sets	144,161
Components, Auto Pilot	1,387,520	Power Supplies	337,152	Timers	31,808
Computers	14,319,635	Pressure Altimeters	38,185	Towers	144,510
Control Ass'ys	26,818	Radar	162,539	Transformers	63,601
Controls, Roll & Pitch	807,038	Radio Sets	32,478,321	Transformer Ass'ys.	25,748
Converters	946,639	Radio Sonde	63,192	Transistors	247,288
Crystal Oscill. Calbr.	52,846	Receivers, Radio	8,042,160	Transmitters	8,209,319
Direction Finder	99,393	Recorders, Code	283,805	Tubes	1,267,451
Frequency Calibrator	36,300	Recorders, Control	170,742	Wattmeters	595,962

After initial adjustments are made, as in photograph, "Mr. Meticulous" automatically performs critical operations in making junction tetrode transistors—tiny experimental devices which may find important uses in the telephone system.

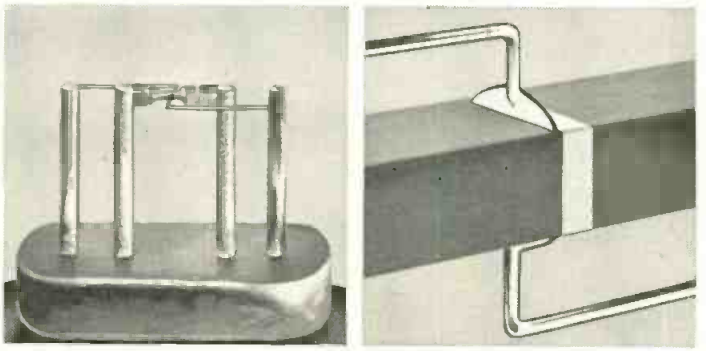
The machine we call "Mr. Meticulous"

Bell Laboratories scientists, who invented the junction transistor, have now created an automatic device which performs the intricate operations required for the laboratory production of experimental model transistors.

It takes a bar of germanium little thicker than a hair and tests its electrical characteristics. Then, in steps of 1/20,000 of an inch, it automatically moves a fine wire along the bar in search of an invisible layer of positive germanium to which the wire must be connected. This layer may be as thin as 1/10,000 of an inch!

When the machine finds the layer, it orders a surge of current which bonds the wire to the bar. Then it welds the wire's other end to a binding post. Afterward, it flips the bar over and does the same job with another wire on the opposite side!

Once only the most skilled technicians could do this work, and even their practiced hands became fatigued. This development demonstrates again how Bell Telephone Laboratories scientists work in every area of telephony to make service better.



Transistor made by new machine is shown in sketch at left above, magnified 6 times. At right is sketch of area where wires are bonded. The wires are 2/1000 inch in diameter, with ends crimped to reduce thickness.

BELL TELEPHONE LABORATORIES

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN MECHANICAL ENGINEERING

Pick Your Package of Power Prudently! *

Compare S-E's New 10 KW VHF TV Transmitter

on ECONOMY and ADVANCED DESIGN FEATURES

* "It would be the point of prudence to defer forming one's ultimate irrevocable decision so long as new data might be offered."
— *George Washington*

ECONOMY PRICED AT $55,000 (F.O.B. Newark)

Now . . . a lower cost transmitter with design and construction features far superior to any other in its power class! Amazingly low price is made possible by use of a newly developed, high efficiency, three phase AmerTran transformer . . . by relocating the power supplies to the cabinets containing the cavities . . . and by the elimination of unnecessary arc-back indicator circuitry (because all rectifier tubes are visible from the front). Low investment makes the transmitt ideally suited for new stations . . offers a practical way for establish stations to replace outmoded equi ment.

OUTSTANDING TUBE LIFE . . . MORE THAN 7,000 HOURS!

Field-proven Amperex AX9904R tubes have demonstrated lives in excess of 7,000 hours in the final amplifier stages of S-E high power transmitters. This domestically produced, air-cooled tube, has a silver plated radiator for better electrical contact. It costs only $210 . . . (about 3¢ an hour to operate). Also, with similar tube types used throughout the transmitter, investment in spares to meet FCC requirements is considerably reduced!

33% LESS FLOOR SPACE

You save on construction and modernization costs as a result of the diminished floor space requirements and lower floor strength demands. The new model uses an area of only 51 square feet; its overall length is 15.6 feet. Practical design resulted in a new low weight of 7,000 pounds for the transmitter. Installation is simplified because smaller S-E frames can be moved easily through normal 3 foot doorways, passageways and elevators. And, the transmitter is adaptable any station layout, conforming to d sired or existing walls and floor are Because each unit is self-containe no external blowers, vaults, trench or plumbing are needed.

ADVANCED DESIGN FEATURES

Modern cabinet design by Dreyfuss utilizes full length tempered glass doors, thereby making all tubes easily accessible and visible from the front at all times. Impressive in appearance, the equipment has built-in safety interlocks to insure electrical neutrality when not operating. And safety control circuitry to protect the transmitter from overloads and power transients. Simplicity of operation is provided by ganged tuning. The RF input to the amplifier is designed as two quarter wave, tuned coaxial lines operating in a groun grid, cathode-input circuit, result in excellent isolation of the input a output circuits. Complete meter equipment and visual control syst provide for a continuous check every major circuit during operati

INSTANT PATCHOVER PLUS "ADD-A-UNIT" FLEXIBILITY!

Patchover is an S-E exclusive development which is used to route a TV signal in order to by-pass an amplifier. Should an emergency arise, in 30 seconds (without loss of air time) the 500 watt driver can be patched over to the antenna and used for transmission at reduced power. This is possible because the resistive input impedence is the same for the final amplifier and the antenna. The "Add-A-Unit" feature provic easy boosting of power output to 40, or 50 KW. This is accomplish simply by adding an S-E amplifier without obsoleting or replacing ex ing equipment.

ADDED S-E FEATURES

Completely air cooled • Single ended coaxial circuits provide exceptional freedom from spurious oscillations and parasitics • Built in sync stretcher permits adjustment of sync-to-picture ratio of the signal • Peak output power 14 KW • Meets and exceeds all applicable FCC requirements for monochrome and color transmission • 208/230 V three phase operation requires no special wiring or transformers • Low power consumption of 30.2 KW at 90% p.f. at black level.

Complete specifications available on request.

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CIRCULATION NOW 27,000

An increase of 5,000, effective with the January 1955 issue, provides greater penetration of plants, stations and laboratories in the primary markets of the industry—Manufacturing, Broadcasting and Armed Forces procurement.

These are the markets with greatest buying power and greatest expansion, industrially and geographically.

The circulation of TELE-TECH is increasing in two ways:

1—Growth of TELE-TECH's Unit Coverage of top-ranking engineers—the magazine's basic readership, preselected for complimentary subscriptions.

2—Making paid subscriptions available to other engineers in research, design, production, operation and maintenance.

Although currently effective, the increased circulation cannot appear in audit statements until the first half of 1955 is audited.

THE ELECTRONIC INDUSTRIES DIRECTORY

Published annually as an integral section of TELE-TECH in June

NEW!

Universal Z-Y Bridge

Measures Impedance . . .

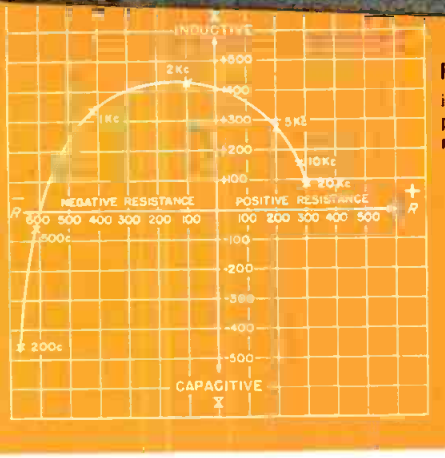
- from 0 to ∞ ohms
- balanced or grounded
- positive or negative
- at any phase angle
- over 20-cps to 20-kc range

The Type 1603-A Z-Y Bridge is the latest addition to the G-R line of precision impedance-measuring apparatus.

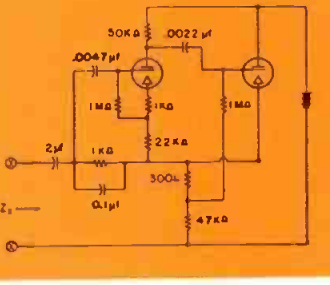
This Universal Z-Y Bridge will measure any impedance — from short circuit to open circuit, at small or large phase angle, and with a basic accuracy of 1% over most of this very wide range. Quadrature components of impedance, R & X or G & B, are measured directly at calibrated 100c, 1kc and 10kc bridge positions. Measurements at other frequencies over the 20 to 20,000 cycle range are made simply by multiplying reactance X or susceptance B readings by a factor which takes into account the difference between operating frequency and frequency setting of the Bridge selector switch.

The ability to measure impedances of any magnitude and with good accuracy with the same instrument can be an extremely valuable asset in many measurement situations. The Z-Y Bridge can be used by chemists for measuring conductivity of liquids in dielectric cells as readily as it can be used for ordinary R-L-C component measurements in the laboratory or production-test department. It will measure . . . open-and short-circuit transformer parameters . . . impedances of batteries and electrolytic capacitors . . . characteristics of audio-transmission networks . . . motional impedance of electro-acoustic transducers . . . Q and resonant frequency of chokes . . . and impedances of feedback loops, since negative real parameters are directly measured.

The Bridge also can be used to determine cable-fault locations and circular-arc plots of liquids or solids having lossy polarizations in the audio-frequency range. These are but a few of the countless applications for this unique and versatile device. *You name it — this Z-Y Bridge can probably measure it!*



Plot of Impedance Z_x of Feedback Circuit . . . . illustrates ability of the Z-Y Bridge to measure any impedance; quadrature components may be positive or negative, real or imaginary.



SPECIFICATIONS

Frequency Range — 20 cycles to 20 kc

Impedance and Admittance Range —
R: ±1000 ohms G: ±1000 μmhos
X: ±1000 ohms B: ±1000 μmhos

Accuracy —

$$R \text{ or } G: \pm\left(1\% + \left[1 \text{ ohm or } 1\ \mu\text{mho} \cdot \frac{f}{f_0}\right]\right)$$

$$X \text{ or } B: \pm\left(1\% + \left[1 \text{ ohm or } 1\ \mu\text{mho} \cdot \frac{f_0}{f}\right]\right)$$

f is operating frequency, f_0 is frequency setting of panel selector switch

Impedances of less than 100 Ω (or 100 μmhos) can be measured on "Initial Balance" dials with considerably greater accuracy —

$$R \text{ or } G: \pm\left(1\% + \left[0.2 \text{ ohm or } 0.2\ \mu\text{mho} \cdot \frac{f}{f_0}\right]\right)$$

$$X \text{ or } B: \pm\left(1\% + \left[0.2 \text{ ohm or } 0.2\ \mu\text{mho} \cdot \frac{f_0}{f}\right]\right)$$

Maximum Applied Voltage — 150 volts, rms

Accessories Recommended —
Type 1210-B Unit R-C Oscillator and
Type 1212-A Unit Null Detector

Accessories Supplied —
2 Shielded Cables for generator and detector

Dimensions — 12½" x 13½" x 8½"

Net Weight — 21½ lbs.

Type 1603-A Z-Y Bridge — $335.00

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"BLOODY IDIOT PROOF"

Perhaps the best compliment paid the entirely new Gates 3-speed transcription turntable at last NARTB Convention was by a visiting British engineer. He commented, after continually trying to foul the speed shifting system, "This turntable is ***bloody idiot proof!***"

The CB-100 mechanism eliminates triple ganged idler wheels, spring tension adjustments, gravity type speed changing, cam arrangements, plungers, auxiliary levers and all touchy adjustments.

In place of all of this, by using Monoball swivel bearings, the direct speed shift method is employed. Instead of falling into speed or springing into speed, the Gates CB-100 is shifted quickly and effectively — by one simple lever, to the speed you select. It is the correct speed too because here is the first 3-speed turntable that may be reset to speed as wear occurs.

Available in both chassis and many complete cabinet models. May we send you further data?

GATES

GATES RADIO COMPANY QUINCY, ILL., U. S. A.

Manufacturing Engineers Since 1922

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Los Angeles, 7501 Sunset Blvd.
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Montreal, Canadian Marconi Co.

THIS IS HELIAX®...

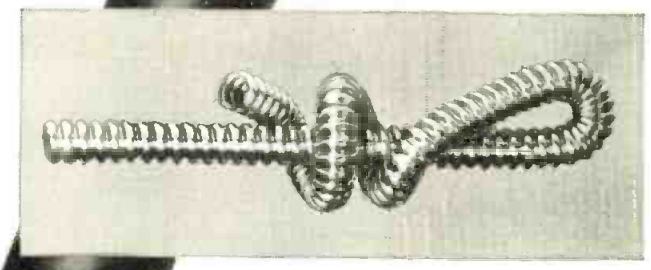
The truly FLEXIBLE Air dielectric cable

This latest ANDREW cable, introduced just 18 months ago, has received phenomenal industry acceptance. This is easy to understand, when you consider that HELIAX offers electrical performance equal to that of the finest copper cables, yet is far lower in price and much easier to install.

HELIAX has its own complete series of connectors, matching the superior electrical performance of the cable. These fittings are pressurized and weatherproofed, and attach easily without special tools.

For a maximum of convenience in the field, HELIAX is normally supplied in complete assemblies, with end fittings factory attached. Available in 7/8" and 1 5/8" sizes. Continuous lengths to 3,000 feet.

Write now for complete engineering data and a sample of this remarkable cable.



The secret of HELIAX lies in its corrugated outer conductor. As demonstrated at the left, this by itself can be bent on its own diameter without breaking, kinking or going out of round. These qualities give HELIAX its unusual flexibility, strength and ease of handling.

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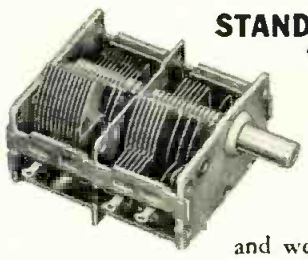
TUNE IN ON RADIO CONDENSER

For Variable Capacitors
Tuners
Electromechanical Assemblies

The experience of Radio Condenser in producing tuners and variable capacitors to individual requirements has consistently proved its value to manufacturers through the right combination of quality and cost. However unusual a problem may be, chances are that R/C specialists have faced a similar problem and solved it.

The products shown on this page are only a brief sampling of units designed, engineered, and manufactured by Radio Condenser. A more complete description of products in each category is given in our catalog, available on request. Or, we will be happy to arrange a direct interview with a Radio Condenser Engineer at your convenience.



STANDARD HOME RADIO TYPE CAPACITORS

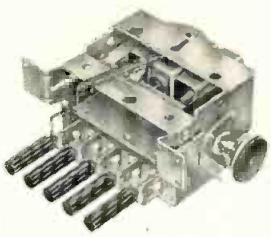
R/C units cover every standard application, including AM-FM receivers. Each is a product of high quality, performance-proved, and well adapted to rapid, low cost quantity production.

CAPACITORS FOR LIMITED SPACE

Among the most recently announced R/C developments is a miniature variable capacitor for transistorized radio receivers, also adaptable to color TV phasing control. R/C accomplished important reductions in size with no sacrifice of stability or calibration accuracy.

UHF AND VHF TELEVISION TUNERS

R/C has provided tuners for major TV manufacturers since the earliest days of commercial TV. While most such tuners are secret designs, R/C has recently developed low cost standard tuners in several styles for UHF and VHF TV.



AUTOMOTIVE RADIO TUNERS

Approximately one-third of all American automobiles are equipped with R/C tuners. Because every automobile radio tuner is an individual case, R/C custom manufacturing experience is an important asset to the radio manufacturer in this specialized field.

STANDARD CAPACITORS FOR SPECIAL APPLICATIONS

Always an important part of R/C activities, design and manufacture of variable capacitors of a special nature are handled by a special division. Products include units for every type of military service, test equipment, etc.

ELECTRO-MECHANICAL ASSEMBLIES

As a contract manufacturer of electromechanical assemblies for industrial and military electronic equipment, automatic data processing systems, etc., R/C also offers engineering assistance in development and modification, leaving you completely free of production worries and details. Complete information on this well-qualified division is available on request.

R/C

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Save!

with

Magnetic Focusing of Picture Tubes

...a typical STACKPOLE Ceramagnet use

Stackpole Ceramagnet rings used as the "heart" of magnetic picture tube focusing units in television sets, spell these advantages:

- Lower material costs by comparison with electrostatic focusing. (Material savings alone run from 50c to $1 in actual instances.)
- Faster, easier, more accurate factory focusing of sets.
- Lower incoming inspection costs because of consistently high quality of magnetic tubes.
- Superior, stable focusing over entire face of large tubes.
- Magnetic focusing readily adapted to use of increased second anode voltages. Less affected by voltage changes.
- Longer tube life.
- Easy service adjustment when tube replacement becomes necessary.

Photo shows unique magnetic focusing unit made by Glaser-Steers Corporation, Belleville, N. J. It uses a single Stackpole Ceramagnet ring 3⅛" in diameter x ½" thick.

new star of the magnetic firmament !

STACKPOLE Ceramagnet CERAMIC MAGNETS

Ceramagnet, the unique new Stackpole ceramic magnet, material excels in high resistance, repelling, aging and other essential characteristics. Its cost—well below that of conventional magnetic materials—opens important new engineering horizons wherever positive, highly permanent attracting, repelling or even "cushioning" might be utilized.

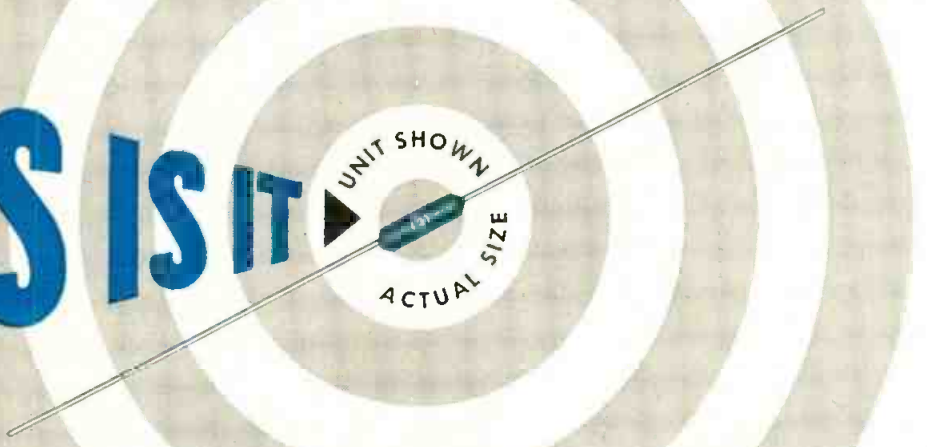
Ceramagnet units can be supplied in almost any desired shapes or sizes. Send details of your application for recommendation and samples.

Electronics Components Division

STACKPOLE CARBON COMPANY

St. Marys, Pa.

THIS IS IT



NEW 3-WATT Blue Jacket®

miniaturized axial-lead wire wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

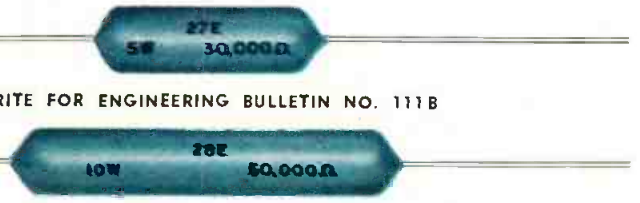
Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (Inches)	D	MAXIMUM RESISTANCE
151E	3	1 7/32	13/64	10,000 Ω
27E	5	1 1/8	5/16	30,000 Ω
28E	10	1 7/8	5/16	50,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE



WRITE FOR ENGINEERING BULLETIN NO. 111B

SPRAGUE ELECTRIC COMPANY • 233 MARSHALL ST. • NORTH ADAMS, MASS.

As We Go To Press...

Instrument-Automation Conference, Sept. 12-16

The Instrument Society of America's 10th annual Instrument-Automation Conference and Exhibit to be held Sept. 12-16 in Los Angeles' Shrine Exposition Hall and Auditorium promises to be the largest national industry event of its kind ever held in the West, according to Dr. A. O. Beckman, general chairman.

More than 500 leading manufacturers, from many parts of the world, will be displaying the latest in instrumentation and automation. In addition to the exhibit, there will be more than 325 technical and clinical sessions during the 5-day conference period.

The increasingly important role being played by electronics in the instrumentation-automation field is reflected this year in the high percentage of electronic manufacturers among the exhibitors.

Theme of the show is "Instrumentation Paces Automation."

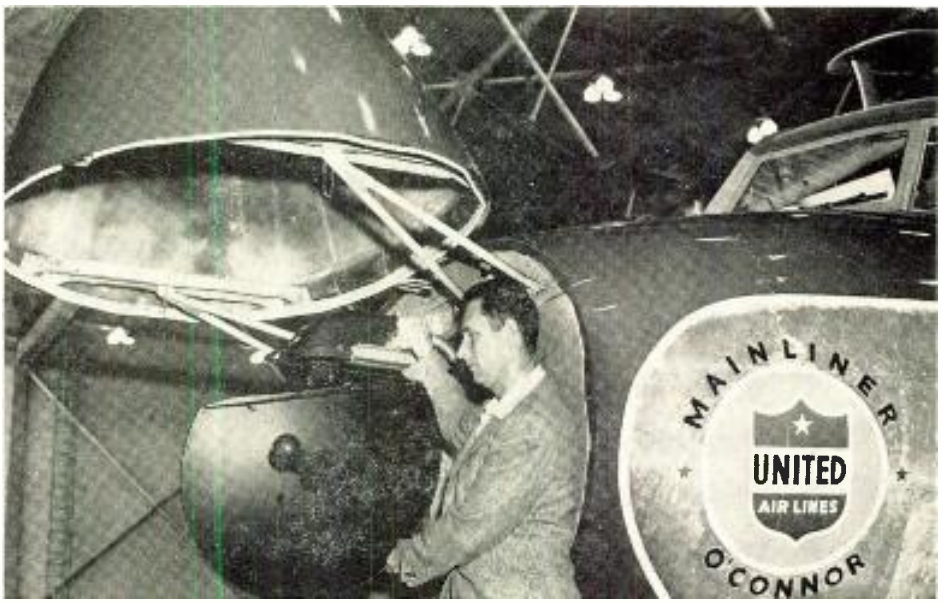
An important sidelight to the conference is the Computer Clinic being held under the auspices of the ISA Data Handling Committee. W. J. Conner, Brown Instr. Div., Minneapolis-Honeywell Regulator Co. will head the clinic committee. The planned program will feature the general use of digital and analog equipment.

DuKane Enters Private Telephone Field

To eliminate the internal communications bottleneck in busy organizations created by a heavy strain on existing telephone service, the DuKane Corp., St. Charles, Ill., has introduced a series of four flexible, automatic phone systems.

J. McWilliams Stone, pres. of DuKane, asserted that two-telephone executives would be the rule rather than the exception in all large organizations within a few years. Surveys conducted by DuKane reveal that more than half the phone calls of the average firm are inside its buildings, thus tieing up important customer incoming and outgoing calls. The four DuKane phone systems completely free switchboard operators for outside calls.

RCA Weather Radar For Air Liners



United Air Lines exec. demonstrates operation of C-Band radar

A new C-Band radar "weather eye" developed by RCA and now being installed in United Air Lines aircraft makes it possible for pilots to detour areas of storms and high turbulence and to navigate through the smooth corridors around the cores of such storms. In addition, the new radar aid also can give pilots a clear picture of terrain features such as streams, mountains and shorelines.

The new units are the result of more than three years research into the potential of radar as a weather-mapping aid. C-Band (5.5 cm.) radar was chosen for its unique moisture penetration characteristics. Areas of heavy rainfall up to 15 mi. can be penetrated and mapped. The over all range of the radar is up to 150 mi. and a range switch allows for adjustments to much shorter distances.

In addition to providing smoother trips for the aircraft and its passengers, C-Band radar will also permit flights in weather conditions which would normally keep the aircraft grounded.

Automation Symposium Sponsored By RETMA

"Electronics for Automation and Automation for Electronics" will be the theme of a 2-day symposium to be held at the Univ. of Pennsylvania Sept. 26-27 under the sponsorship of the RETMA Engineering Dept.

Highpoint of the symposium will be a panel discussion on "The Future of Automation." Chairman for the discussion will be Dr. W. R. G. Baker of G.E. and a featured speaker will be Maj. Gen. James D. O'Connell, Chief Signal Officer, U.S. Army.

Additional technical sessions will explore "Mechanization for High Volume Assembly," "Data Sensing, Processing and Utilization," "Automation for Low Volume Production," and "Redesign for Automation."

AT&T Selects Landing Site For Cable to Alaska

The Long Lines Dept. of the American Telephone and Telegraph Co. has selected a location near Port Angeles, Wash., as the landing site for the Company's underwater telephone cable to Alaska. The new cable system, when completed, will provide a short, direct route between the U.S. and Alaska and will be able to carry 36 message circuits.

The submarine cable, which will be placed in the Strait of Juan de Fuca, off Port Angeles, will interconnect with a submarine cable between Ketchikan and Skagway, which is now being constructed by the Alaska Communications System, a division of the Army Signal Corps.

As We Go To Press . . . (Continued)

Elgin Develops "Wonder" Battery

A button-size battery about the volume of a penny and capable of storing enough energy to deliver a constant voltage for 2 yrs., has been developed by Elgin National Watch Co. The new "microcell," claimed to be the first ever made that will not leak, swell or gas, opens up vast new possibilities in providing a highly dependable source of electrical energy for hearing aids, small portable personal devices, and military and industrial applications. The present cell, made for an electronic wrist watch now under development, is so flexible it can be made almost any size or shape desired.

A. P. Barton, General Mgr. of Elgin's Electronic Div., said the secret of the development is the use of indium—(a soft silvery metal previously viewed as a scientific curiosity)—as an anode. He said the new cell has maintained full strength in storage tests running more than a year thus far without deterioration. The battery delivers about 1.15 v compared with 1.5 v for most other miniature cells, but it is said that it could be easily stepped up to 1.37 v by using another cathode material.

Univ. of Houston's KUHT-TV Given Financial Support

The Univ. of Houston's KUHT-TV, a pioneer educational station in the U.S. since it first went on the air in May 1953, will be the recipient of $10,000 grants from each of three commercial TV stations in the Houston area. KGUL-TV, KPRC-TV, and KTRK-TV will each contribute this amount to the university during the academic year beginning Sept. 1955. General A. D. Bruce, Univ. of Houston president, expressed delight that the commercial TV stations in the area have recognized the importance of educational television.

GE Supplies Radar Height-Finders for the Air Force

Powerful radar height-finders, resembling oil-drilling rigs in the Gulf of Mexico, are being constructed for the Air Force's "Texas Tower" offshore radar warning stations as a protective measure against sneak attack. In addition to their radar warning function, they will serve as weather stations and as radio and radar aids in air and ship navigation. Developed by the General Electric Company's Heavy Military Electronic Equipt. Dept. in collaboration with the Rome Air Development Center, Griffiss Air Force Base, Rome, N.Y., the radar height-finders will be housed in ball-shaped radomes rising from the decks of the stations. Each station will have height-finders along with a search radar and will be part of the Continental Air Defense Command's radar network protecting the country.

Kay Lab Designs Battlefield TV System

Actual battle conditions can now be observed clearly and distinctly at a command post miles away by means of a TV system designed especially for battlefield use by Kay Lab, 5725 Kearney Villa Rd., San Diego, Calif.

The system, which is to be installed on the proving grounds at Ft. Huachuca, Ariz., will permit instant relaying of decisions affecting troop movements, as well as communications with supporting planes. It will feature a special TV camera developed by Kay Lab.

NEW RELAY-DESIGN TEAM

To design and manufacture sub-miniature relays to operate in transistor circuitry and to be no larger than the transistors themselves is the project assigned to this new team of engineers assembled by Phaostron Co., 151 Pasadena Ave., S. Pasadena, Calif. Seen together in this group picture are (l. to r.): C. H. Dibble, C. R. Rhodes, E. W. Carlson, I. W. Eisenberg, P. Chamberlain, C. A. Hale, R. C. Johnstone, J. Q. Adams

Coming Events

A listing of meetings, conferences, shows, etc. occurring during the month of Sept. 1955

Aug. 26-Sept. 4—German Radio, Television, Gramophone and Radiogram Exhibition, Dusseldorf, Germany.

Sept. 6-17—Production Engineering Show and Machine Tool Show, Navy Pier and International Amphitheatre, Chicago, Ill.

Sept. 10-12—1955 Maintenance Clinic, sponsored by the Instrument Society of America, Founders Hall of the Univ. of Southern Calif., Los Angeles, Calif.

Sept. 12-16—10th Annual Conference and Exhibit, sponsored by **ISA,** Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

Sept. 14-16—ACM General Meeting, Moore School of Electrical Eng., Univ. of Pennsylvania, Phila, Pa.

Sept. 14-16—The Second National Annual Meeting of the IRE Professional Group on Nuclear Science (PGNS), Oak Ridge, Tenn.

Sept. 17—Symposium on Automation, sponsored by the Cedar Rapids section of the IRE, Cedar Rapids, Iowa.

Sept. 20-22—10th Anniversary Industrial Packaging and Materials Handling Show, Kingsbridge Armory, New York, N. Y.

Sept. 23-24—Annual BTS Meeting, sponsored by IRE, Hamilton Hotel, Wash., D.C.

Sept. 26-27—6th Annual Meeting and Conference of the IRE Professional Group on Vehicular Communications, Multnomah Hotel, Portland, Ore.

Sept. 26-27—RETMA Symposium on Automation, University of Pa., Philadelphia, Pa.

Sept. 26-28—Prof. Gp. on Communications Systems, IRE, Symposium, Utica, N. Y.

Sept. 26-30—The First Trade Fair of the Atomic Industry, Sheraton-Park Hotel, Washington, D. C.

Sept. 27-Oct. 1—Int'l Analog Computation Meeting, Brussels, Belgium.

Sept. 28-29—Industrial Electronics Conference, sponsored by the AIEE and IRE, Detroit Rackham Memorial Auditorium, Detroit, Michigan.

Sept. 30-Oct 2—High Fidelity Show, Palmer House, Chicago, Ill.

Sept. 30-Oct. 2—International Sight and Sound Exposition, Inc., Palmer House, Chicago.

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.....HERE'S YOUR PRACTICAL GUIDE TO GEAR TRAIN -CONTROL MOTOR COMBINATIONS

Now you can design high-quality, precision servo systems with prior knowledge of delivery dates to meet hot production deadlines. Transicoil's new gear motor bulletin gives you, for the first time, complete availability data on the units you need to meet tough space and performance requirements.

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Electronic Industries News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

AMPEX CORP., 934 Charter St., Redwood City, Calif., has started expanding its research facilities with the establishment of a separate research department directed by Walter T. Selsted.

ASTRON CORP., 255 Grant Ave., East Newark, N. J., has announced the opening of new facilities to expand distribution of its precision capacitors and RF filters to the West Coast area. The company has contracted for large scale warehousing in Los Angeles.

AUDIO DEVICES, INC., 444 Madison Ave., New York 22, announced the development of a new super thin audiotape which allows 2400 feet of tape recording on a single seven-inch reel.

BELL TELEPHONE SYSTEM has added WNDU-TV Notre Dame, Ind., to its nationwide network of television facilities. This is the 364th station in the U. S. to become affiliated with the system, it was announced by the Long Lines Department of American Telephone and Telegraph Co., N. Y.

BLONDER-TONGUE LABORATORIES, 526-536 North Ave., Westfield, N. J., has been granted two U. S. patents covering wideband RF amplifying circuits.

H. H. BUGGIE, INC., has consolidated its manufacturing, engineering, research and sales departments in a new plant on Route one, near Millbury, Ohio, with a mailing address at Box 817, Toledo 1, Ohio.

CBS-COLUMBIA, Long Island City, N. Y. has converted about one-fourth of its manufacturing facilities to government and industrial operations.

EMERSON CORP., 5th Ave. & 59th St., N. Y. has been granted Patent No. 2,707,356 by the U. S. Patent Office for the "Autobrader," a fully automatic component adjusting machine which insures accurate production of printed electronic circuits.

ERIE RESISTOR CORP., Erie, Pa., has available a new line of small size, high capacity ceramicons. In three sizes, they are rectangular, have a phenolic dipped coating, wax impregnated #22 hot tinned copper leads.

FAIRCHILD RECORDING EQUIPT. CO., 154th St. and 7th Ave., Whitestone, N. Y., has announced a new policy permitting owners of the older 215 Series Cartridges to have them completely factory rebuilt to the new 220 type at a special price of $29.50.

THE FORD FOUNDATION OF NEW YORK has made a grant of $26,500 to Stanford Research Institute to assist the participation of foreign scientists and engineers in the World Symposium on Applied Solar Energy next November.

GENERAL ELECTRIC, Syracuse, N. Y., announced the reorganization of the manufacturing section of the radio and television department. Mr. Franklin Greene, Jr. has been appointed manager of the Television Manufacturing, Radio and Television Department. Mr. William N. Maddox, became manager of the Radio Manufacturing division.

GIANNINI DATEX DIVISION has moved into a new building, located at 1307 So. Myrtle Ave., Monrovia, Calif. The company produces digital data recording equipment for use in wind tunnel instrumentation, radar recording, gas dynamics, jet enngine test facilities, computer input, and other applications requiring rapid correlation of data.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 67 Broad St., N. Y., announced that its Farnsworth Electronics Co., Ft. Wayne, Ind., has recently received orders in excess of $10,000,000 for substantial quantities of control and test equipment in connection with the government guided missile program.

INSTRUMENTS FOR INDUSTRY, INC., Mineola, N. Y., was awarded an electronics study contract by the Wright Air Development Center of Air Research and Development Command.

JAMES VIBRAPOWR CO., 4036 No. Rockwell St., Chicago, Ill., has started construction on their new plant to be located adjacent to their present plant. The new address will be 4050 No. Rockwell.

LAVOIE LABORATORIES, INC., Morganville, N. J., have acquired Matawan Electronics Co., and Shore Electronics which will be operated as subsidiaries, it was announced by R. Edward Stemm. Mr. Stemm was recently appointed representative for the parent company in Illinois, Wisconsin and Minnesota.

LITTON INDUSTRIES, INC., 336 No. Foothill Rd., Beverly Hills, Calif. announced an offer for exchange of its common stock to shareholders of West Coast Electronic Co., Los Angeles, Calif., a subsidiary. The offer is being made on the basis of two shares of Litton's common stock for a package of West Coast Electronics stock totalling 18 shares preferred and 1.3 shares common.

MERIDIAN METALCRAFT INC., design engineers and manufacturers of waveguide parts and other products, celebrated its 10th Anniversary in its new building erected at 8739 So. Millergrove Dr., Whittier, Calif.

MICRO SWITCH, Freeport, Ill., a division of Minneapolis-Honeywell Regulator Co., has departed on a nationwide tour with a rolling display of the latest in precision switches, to show industrial designers and plant operators how plant equipment and machinery can be made safer, more automatic, and more efficient.

MINNESOTA MINING & MANUFACTURING CO., St. Paul 6, Minn., has been issued an access permit by the Atomic Energy Commission allowing the firm's research groups to study AEC files on non-military uses of atomic energy.

POTTER INSTRUMENT CO., 115 Cutter Mill Road, Great Neck, N. Y., enlarged its production capacity to include an entire new building. The step was due, in part, to the response of the electronic industry to the announcement of the Potter Magnistor.

RADIO CORPORATION OF AMERICA, Camden, N. J., plans two all-transistor portable radios, one in miniature size with six transistors and the other featuring a larger loudspeaker and case with seven transistors.

RADIO CORPORATION OF AMERICA, Camden, N. J., will install a multi-service microwave radio relay system, providing voice communication, VHF control, and telemetering circuits for the Union Oil Co., Los Angeles, Calif. The system will extend from the utility's Mulholland control center in Los Angeles to a pumping station at Torrey, Calif., and on to the company's Santa Paula, Calif., branch office. Microwave link will cover an overall distance of approximately 40 miles.

RADIO RECEPTOR CO., Brooklyn, N. Y., will temporarily suspend the manufacturing of germanium transistors until demand for the components expand. The company will continue to manufacture germanium diodes and will increase its development work on silicon transistors and diodes.

The **RAMO-WOOLDRIDGE CORP.**, 8820 Bellanca Ave., Los Angeles 45, Calif. has announced the establishment of a new division, the Aeronautics Research Laboratory, and the appointment of Dr. Milton U. Clauser as its director. Activities of the lab will be aimed at the advanced studies and projects in aerodynamics and related fields.

REPUBLIC FOIL & METAL MILLS, INC., Danbury, Conn., announced the incorporation of Republic Etched Products, Inc. for the purpose of etching extra high purity aluminum foil for use in electrolytic types of capacitors.

SCHENECTADY VARNISH CO. and the **INSL-X CO.**, have formulated a sales tie-up offering a complete line of insulating varnishes, impregnants, wire enamels and fungicidal coatings to manufacturers of electronic components and related assemblies. Headquarters for the joint sales, which will be handled by the Insl-X Sales Company, is located at 26 Rittenhouse Place, Ardmore, Pa.

SERVO CORP. OF AMERICA, New Hyde Park, L. I., N. Y., has announced the election of Mr. Henry Blackstone, president of the company, as vice-president of the Institute of Navigation, at its annual meeting in June at the Air Univ., Montgomery, Ala. Mr. Blackstone is a charter member of that organization, and attended the founding meeting at UCLA in 1945.

SPERRY ELECTRONIC TUBE DIVISION, Gainesville, Fla., plans immediate expansion of research & development work requiring additional engineering staff.

STANDARD COIL PRODUCTS CO. INC., announced the formation of a wholly-owned Canadian subsidiary, Standard Coil Products (Canada) Limited. The company's other wholly-owned subsidiary is Kollsman Instrument Corp., Elmhurst, N. Y.

STANDARD ELECTRONIC CORP., 285 Emmett St., Newark 5, N. J., received an order for a 50 kilowatt TV amplifier from Mr. Oscar Hirsch, station KFVS-TV, Cape Girardeau, Mo.

SYNTHANE CORP., Oaks, Pa., manufacturers and fabricators of laminated thermosetting plastics has moved its Rochester, N. Y. sales office to 137 W. Commercial St., East Rochester, N. Y.

TGBO-TV, in Guatemala City, Central America's first television station, will go on the air this summer, possibly as the first link in a Pan American chain connecting the Western Hemisphere, according to Ernest A. Marx, director of the International Division of Allen B. Du Mont Laboratories, Inc.

TECHNICAL APPLIANCE CORP. (Taco) of Sherburne, N. Y. has awarded 4 scholarships, each valued at $2,500, to four Central New York students selected for outstanding high school work. The recipients are: George Sleeper, who will major in Electrical Engineering at R.P.I.; Rex Sawyer, Management Engineering at Union College; Douglas Jensen, R.P.I.; and Wayne Wales, Alfred University.

VITRO CORPORATION OF AMERICA, 261 Madison Ave., N. Y. C., has purchased for cash a substantial stock interest in Thieblot Aircraft Co., Inc., of Bethesda, Md.

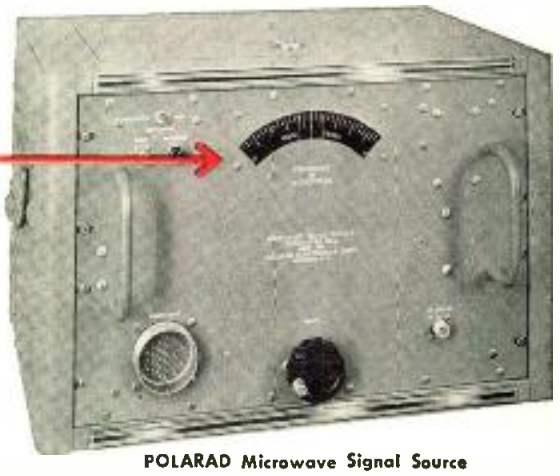
WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh, Pa., announced the formation of an industrial heating division which will combine the functions of the company's induction heating activities at Baltimore, Md., and the industrial heating activities at Meadville, Pa.

WIEDEMANN MACHINE CO., 4276 Wessahickan Ave., Phila. 32, Pa. will introduce a completely new automatic turret punch press in Booth 1420 at the Machine Tool Show in Chicago's International Amphitheatre, Sept. 6-17.

MORE NEWS on page 22

BROADBAND MICROWAVE POWER SIGNALS

as fast as you can turn the dial



POLARAD Microwave Signal Source

Make microwave measurements rapidly.

No mode charts or slide rule interpolations.

Turn only one dial and read the frequency *directly* on the dial with assured power output throughout the entire range.

Polarad's automatic tracking mechanism corrects reflector voltages for you as the klystron cavity is being tuned. Frequency accuracy is within 1%.

There are 5 models available, covering the range – 650 to 10,750 mc . . . each has approximately a 2:1 frequency range with continuous tuning . . . power output: 10 to 100 mw . . . external modulation: square wave or fm . . . temperature compensated klystron tube.

Polarad Microwave Signal Sources save engineering man hours in the laboratory and in the factory.

Unusual economy and accuracy in making antenna and transmission loss measurements and standing wave determinations in the laboratory—excellent for microwave component testing in the factory. Write for a complete catalog and data today.

Model KX, Klystron Power Supply, especially designed for Polarad Signal Sources. Works with all 5 models. Has special 1000 cps square wave output for modulating purposes.

MINIMUM POWER AVAILABLE FROM POLARAD SIGNAL SOURCES IN THE RANGE OF 650 TO 10,750 MC

		MODEL SSR	MODEL SSL	MODEL SSS	MODEL SSM	MODEL SSX
FREQUENCY RANGE		650-1300MC	1050-2350MC	2200-4550MC	4350-8250MC	8000-10,750MC
MINIMUM POWER AVAILABLE (mw)	Low Range	150	80	15	10	13
	Middle Range	400	150	60	70	30
	High Range	100	100	40	15	10

Signal Sources in the range 10,750 to 50,000 mc available on special order.

Polarad Electronics Corporation

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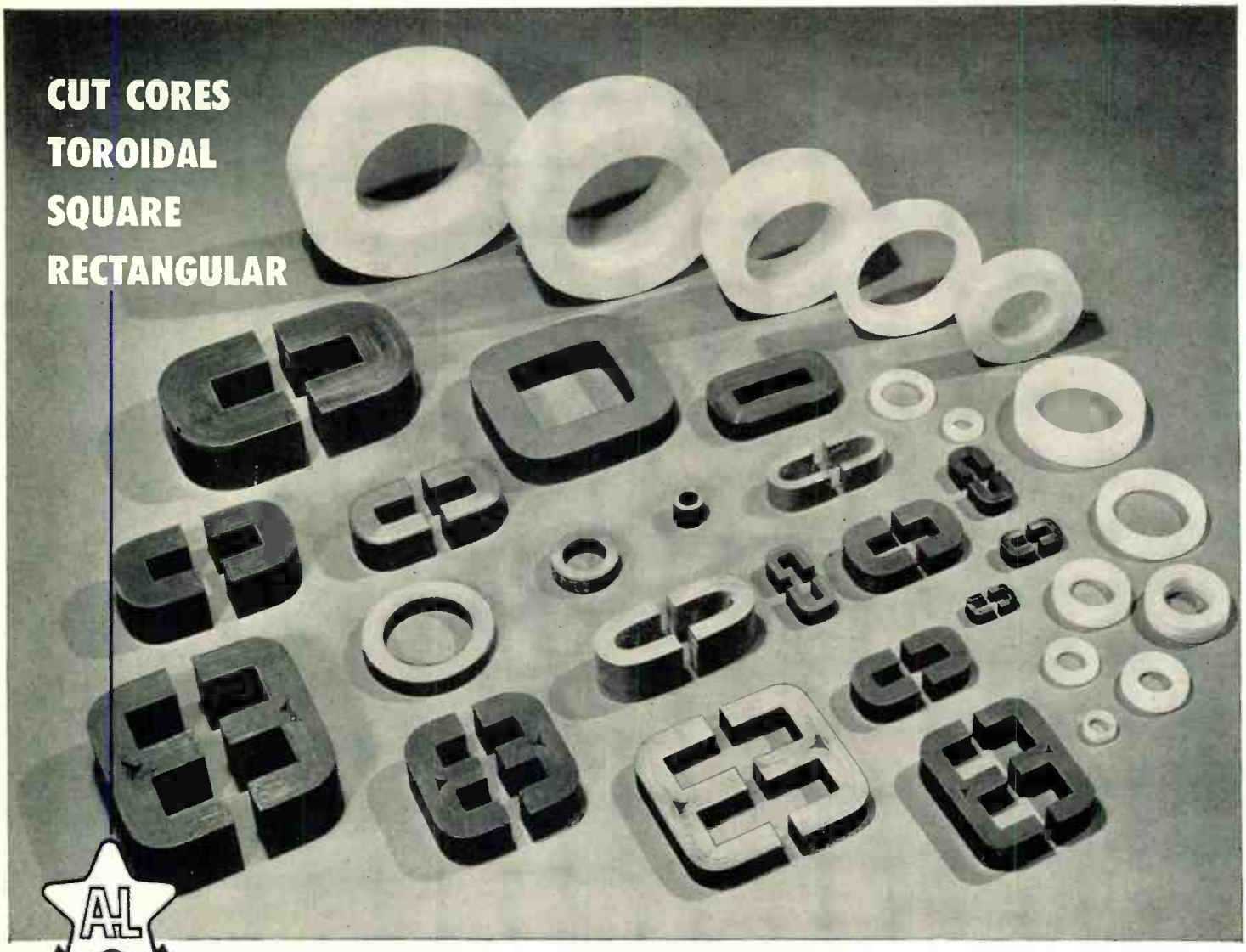

Anything You May Need in TAPE-WOUND CORES

RANGE OF MATERIALS

Depending upon the specific properties required by the application, Arnold Tape-Wound Cores are available made of DELTAMAX . . . 4-79 MO-PERMALLOY . . . SUPERMALLOY . . . MUMETAL . . . 4750 ELECTRICAL METAL . . . and SILECTRON.

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Let us help with your core problems for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, etc.

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Over the twelve years that Fairchild has been making precision potentiometers — from our first unit (Type 736), on through the more than eighteen different types now in production — we have established and are carrying out a research and development program on new designs and materials, techniques and equipment that is constantly improving our potentiometer reliability. The results of this program are quickly applied to production units and these improved methods and designs are maintained by comprehensive quality control and type testing programs.

MAXIMUM RELIABILITY...

how do you get it?

Reliability in precision potentiometers resolves itself into three basic factors; longer shelf life, longer rotational life, and longer environmental life. Fairchild has increased the average shelf and rotational life expectancy of precision potentiometers for beyond usually expected life cycles, in one way, by compounding and using special potentiometer lubricants. Life expectancy and stability under abnormal operating conditions have been vastly increased through the use of precision-machined aluminum alloy case construction. Epoxy resin insulation, one-piece Paliney conductive springs and contacts, and precious metal alloy resistance elements, for certain applications, also contribute to increased life and functional reliability. Whether one or all of these factors of reliability are important to you, you'll do better to choose Fairchild Precision Potentiometers. For specific facts, write Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, Long Island, New York, Department 140-64E1.

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PRECISION POTENTIOMETERS

Buss Fuses give you..

Double Protection

. . Against loss of Customer Satisfaction

To make sure of proper operation under all service conditions — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

That's why BUSS fuses won't blow when trouble doesn't exist. Useless shutdowns caused by poor quality fuses blowing needlessly are not only irritating to customers — but customers' confidence in your product or service could be jolted.

However, when there is an electrical fault BUSS fuses open to prevent further damage to equipment — saving users the expense of replacing needlessly damaged parts.

When you standardize on BUSS fuses, you are doubly safe.

MAKERS OF A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

SAVE ENGINEERING TIME ON ELECTRICAL PROTECTION PROBLEMS

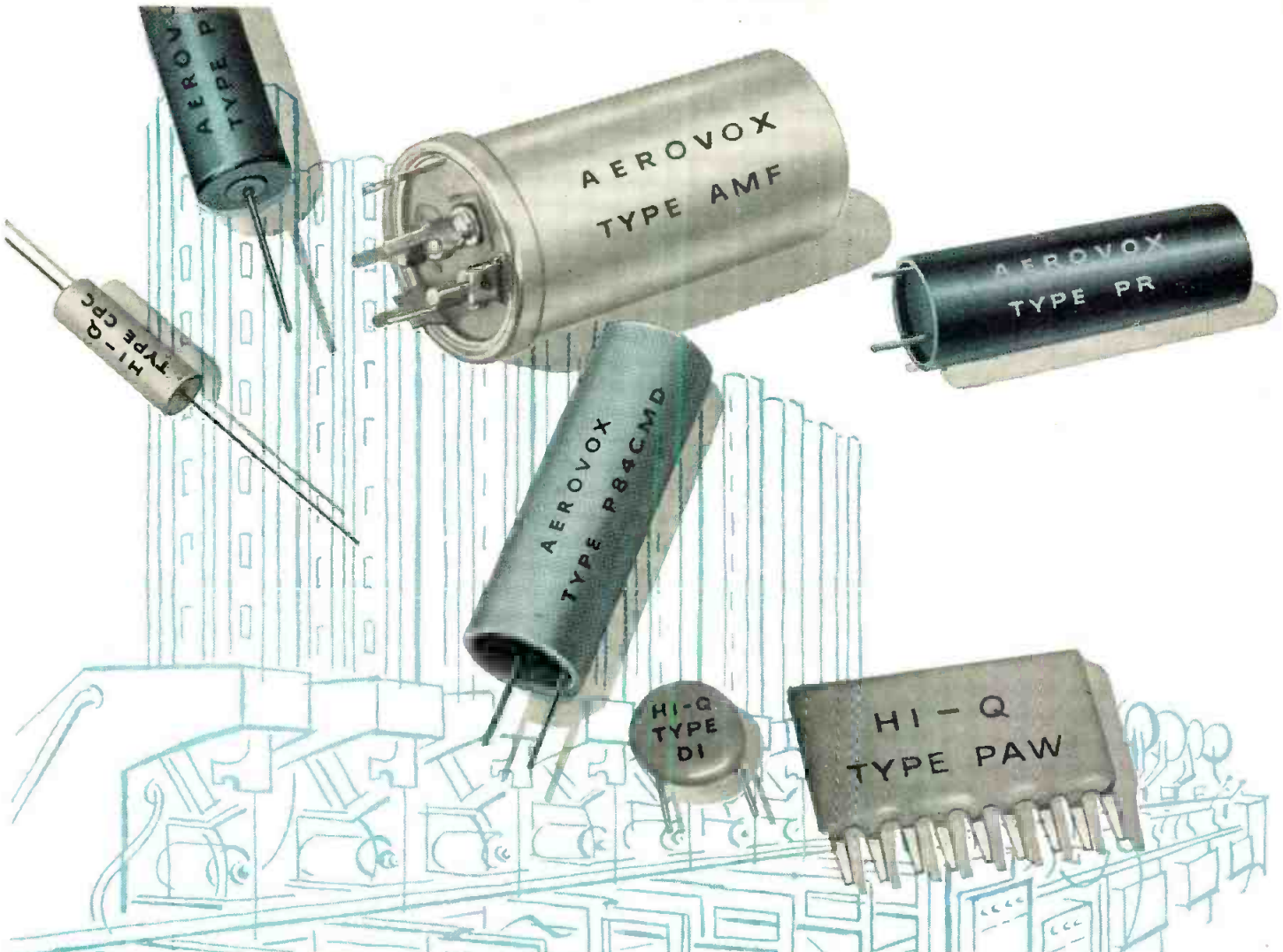
The BUSS fuse research laboratory and its staff of engineers are at your service to help you with problems involving electrical protection. Submit description or sketch and tell us your requirements.

Whenever possible, the fuse or fuse mounting selected will be available in local wholesalers' stocks, so that your device can easily be serviced.

Be sure to get the latest information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

BUSSMANN MFG. CO. FUSETRON TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION BUSS Div. McGraw Electric Co.

University at Jefferson St. Louis 7, Mo.



AUTOMATION COMPONENTS

All inclusive! That distinguishes the Aerovox automation program from all others. Not limited to any one phase, we are dealing with mechanical, material, electronic, electrical, production and economic aspects for **across-the-board** automation.

Here is an outstanding staff of mechanical experts. A leading machinery company is now incorporated in the Aerovox group. Notable automation developments and pilot plants, including latest printed wiring and module assemblies, are blazing new trails. Aerovox is collaborating with all the mechanized-assembly developers, while our electronic specialists, working side-by-side with mechanical geniuses, are coming up with new components and packaging, function-fitted to mechanized assembly methods.

Such **across-the-board** automation, implemented by outstanding research, engineering, components and production techniques, is available to those interested in **advanced mechanized production.**

Write on your business letterhead for this fact-packed Automation Manual. And submit your automation interests, requirements and problems to our Director of Automation.

AEROVOX Capacitors

AEROVOX CORPORATION

NEW BEDFORD, MASS.

Letters . . .

High Fidelity Crossroad

Editors, Tele-Tech

I am sure you will be glad to know that the suggestions stemming from your editorial "High Fidelity at the Crossroads," June, 1955 dealing with standardization of high fidelity concepts has been placed on the agenda of the IRE Committee on Electroacoustics, and the IRE Committee on Recording and Reproduction. The subject will be discussed at the forthcoming meetings of these committees and I will forward the results of these meetings to you since I know you will be interested in them.

B. B. Bauer
Vice-President, Engineering
Shure Brothers Inc.
Chicago 10, Illinois

Conventions and Shows

Editors, Tele-Tech:

Your editorial about conventions and shows is most interesting.

And I think your suggestion of three semi-national shows is also on the right track.

Incidentally, how about the National Electronics Conference at Chicago being made the third Midwestern Show?

But what would you suggest doing about the many other Shows, and the overlapping fringes of all of them?

Probably the biggest example is the Instrument Show which certainly overlaps very heavily with either the IRE or the Wescon Show.

Then there is the Chemical Show and the Automation Show and many others, all of which are electronic to a greater or lesser degree, and in which many of us have as much interest as we do in the strictly electronic show.

If you can figure out a solution to this entire problem, it would be of great benefit to the entire industry—and those of us who have to spend a lot of time at the shows.

Ken Hughes
Kenneth E. Hughes Company
Union City, New Jersey

Editors, Tele-Tech:

In accordance with your editorial on page 69 of the August issue of Tele-Tech, I would like to comment to the effect that I believe that no additional conventions are required, particularly in the midwest.

As you are undoubtedly aware, there is an annual Electronics Exhibition in Chicago, the National

(*Continued on page* 117)

REVERE

ROLLED
Printed Circuit Copper

No longer need the lack of material deter you from switching to printed circuitry. Revere *Rolled* Printed Circuit Copper is now available to laminators in standard coils of 350 lbs. in widths up to 38″, and in .0015″ and .0027″ gauges weighing approximately 1 oz. and 2 oz. per square foot.

Revere *Rolled* Printed Circuit Copper is accurate in gauge, of high conductivity, and uniform density. It is easily etched and soldered.

The next time you order blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

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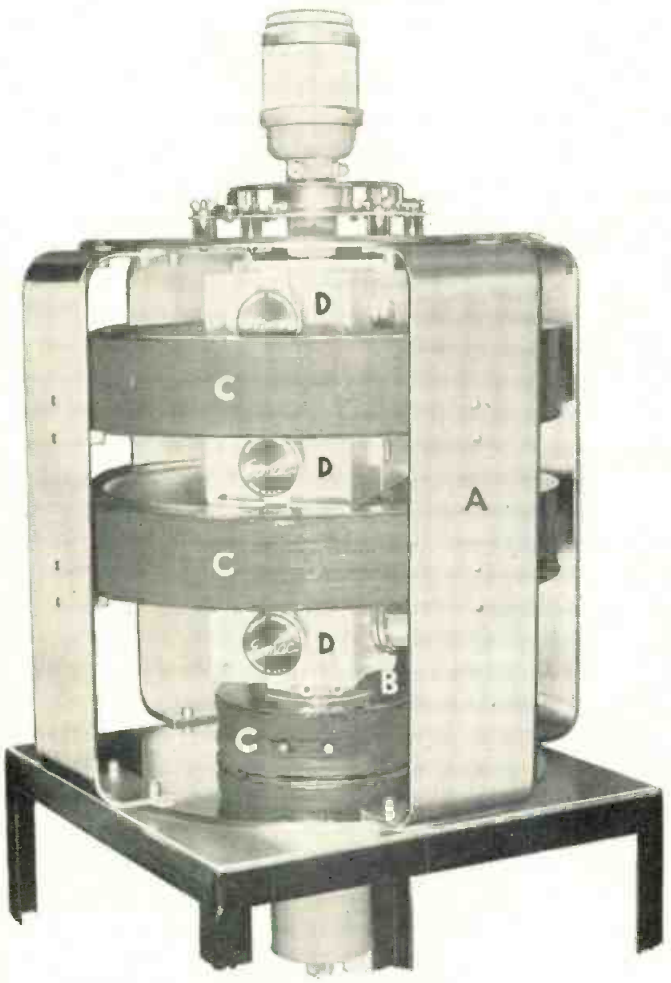
Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

Eimac Amplifier Klystrons and Circuit Components

—the easy, economical approach to high power, UHF/microwave transmitters



Design and construction of a high power UHF/microwave transmitter for beyond-the-horizon communication and other microwave applications is simple and straight-forward with an Eimac amplifier klystron and circuit components. In fact, it's easier to build than a low frequency Class C amplifier. Eimac high power amplifier klystrons, plus Eimac circuit components consisting of A) Magnetic framework B) RF output load coupler C) Magnetic beam-control coils and D) Convenient tuning wide range RF resonant cavities comprise the essential elements of a final amplifier package. By adding conventional power supplies, control circuits, driver and cabinets to the Eimac klystron-circuit component package, high power at UHF is easily obtained. Eimac developed klystron and circuit components provide equipment manufacturers with the easy economical approach to high power microwave transmitters. In many cases, existing low power equipment can be used as a driver for the higher powered amplifier.

Radio Frequency circuitry is completed outside the vacuum system of Eimac klystrons through circuit components. This allows unmatched economy by eliminating repurchase of costly RF circuitry with each tube replacement.

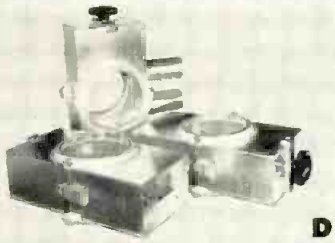
The reliability and performance of Eimac klystrons is proven, as they were employed extensively in established microwave scatter-type communication systems.

For an easy and economical approach to reliable high power microwave transmitting equipment, investigate the incomparable capabilities of performance-proved Eimac developed klystrons and klystron circuit components.

A **Magnetic frame work**

B **Output load coupler**

C **Magnetic beam-control coils**



D **Resonant cavities**

EIMAC AMPLIFIER KLYSTRONS

	FREQUENCY RANGE—MC	CW POWER
3K3000LA	400-600	2000w
3K3000LQ	760-980	2000w
3K20,000LA	470-580	5000w

	FREQUENCY RANGE—MC	CW POWER
3K20,000LF	580-720	5000w
3K20,000LK	720-890	5000w
3K50,000LA	470-580	10,000w

	FREQUENCY RANGE—MC	CW POWER
3K50,000LF	580-720	10,000w
3K50,000LK	720-890	10,000w
3K50,000LQ	850-1000	10,000w
4K50,000LQ	750-1000	10,000w

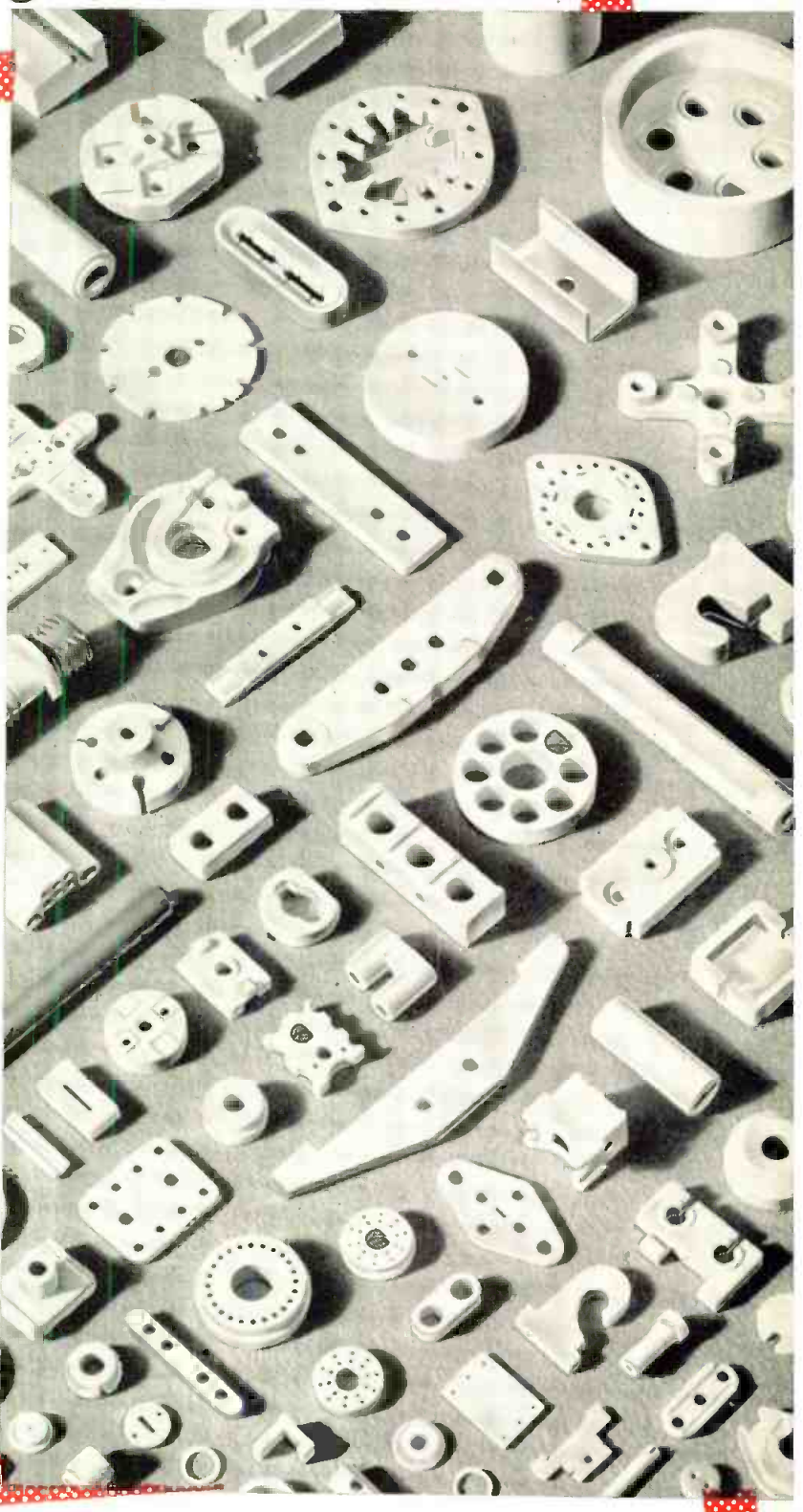
For further information write our technical service department.

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
World's Largest Manufacturer of Transmitting Tubes

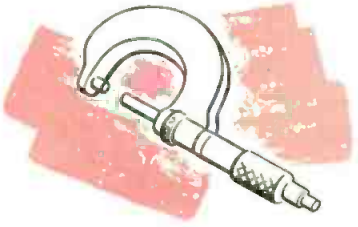
Save assembly time . . . with quality-controlled ceramics

made of

ALSiMAG®

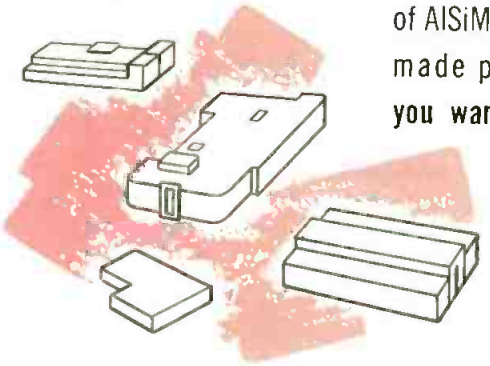


Your line workers will appreciate the ease and speed with which they can assemble AlSiMag ceramics. Your production planning staff will be well pleased with the excellent quality as well as the rapid delivery of these parts.



Physical dimensions and tolerances are checked at every key stage of manufacture by thoroughly trained Quality Control inspectors to insure shipment of a superior product.

Four large, completely equipped plants assure you of hundreds—or hundreds of thousands—of AlSiMag precision made parts **when you want them.**



You can confidently specify AlSiMag ceramics—backed by over fifty years of specialized experience in the technical ceramics field.

54TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

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TELE-TIPS

TECHNICAL WRITING IMPROVEMENT SOCIETY, although not yet formally organized, already has more than 100 members. John L. Kent, chairman, of Consolidated Engineering Corp., Pasadena, Calif., points out that better technical writing is needed if the reader is going to read all that he should. Typical scientist's or engineer's contributed articles take too long to get to the point. The only way to do is to write the articles better and shorter.

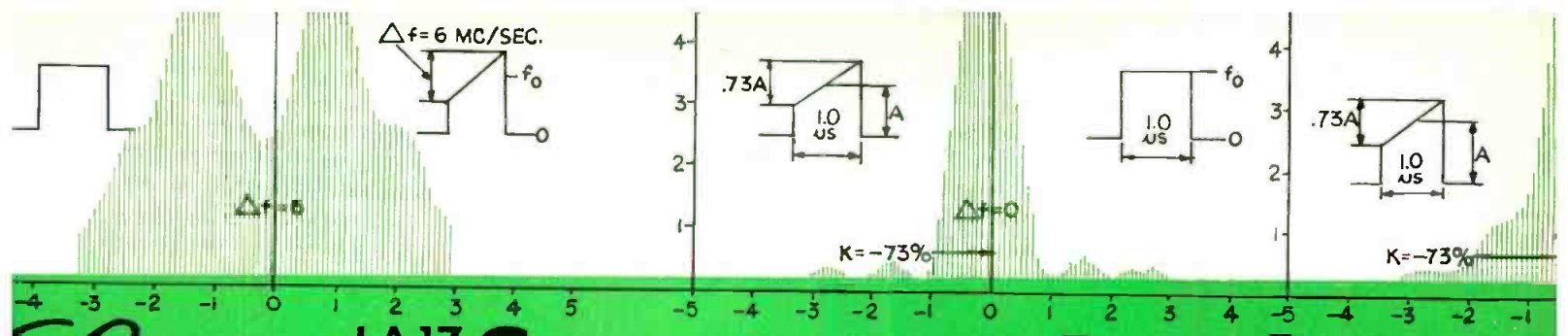
MAGNESIUM MOUNTING BASES for electronic equipment in aircraft save 25% in weight for each base. The Electronic Division of T. R. Finn and Co. Inc., 200 Central Ave., Hawthorne, N. J., announces that it has overcome the welding problems associated with lightweight magnesium and that by padding stainless hardware with nylon, the galvanic action between the magnesium and the hardware is controlled.

EDUCATIONAL TV has been proposed as a means to alleviate the teacher shortage by W. J. Morlock, GE executive. Results of a recent study indicate that TV instruction was remembered at least as well as regular instruction and in some subjects much better. Also, once a lecture had been prepared by well qualified educators, a less experienced individual was just as effective in presenting the material as teachers with a great deal of experience.

SYNTHETIC PAPER made wholly from nylon fiber has just been produced by Riegel Paper Corp., 260 Madison Ave. The new paper is almost impossible to tear by hand. It is highly resistant to chemical attack, molds, bacteria and light and also absorbs very little moisture. Anticipated commercial applications include heavy-duty bags, map and tracing papers.

RADAR SUPPLANTS searchlights. Thus what to do with the old 60-in. searchlights of World War II? The Corps of Engineers Research and Development Laboratories at Ft. Belvoir came up with an answer. They have been transformed in self-contained mobile units to supply

(*Cnntinued on page* 32)



Lavoie LA 17 Spectrum Analyzer

- Finer Resolution . . . 10 Kilocycles
- Complete in one unit . . . no extra tuning heads required
- Single Dial tuning . . . Use of stable triode oscillators eliminates klystrons
- Smooth tuning without backlash
- Ruggedized to military specifications
- Simplicity of operation permits use by production line personnel
- Usable to 34,000 megacycles

SPECIFICATIONS

DIMENSIONS

25-7/16" high by 20⅛" wide by 19⅛" deep.

WEIGHT

150 pounds

PRESENTATION

5CPIA 5" cathode-ray tube (other persistances available).

SENSITIVITY

At signal to noise ratio 2:1, and spectrum width 25 megacycles:
— 75 dbm at 10 mc to
— 50 dbm at 16,000 mc

RANGE

10 megacycles to 16,000 megacycles calibrated. Usable 1 to 34,000 megacycles.

ACCURACY

Dial accuracy ±1.0% at the operating frequency of the local oscillator.

SPECTRUM WIDTH

0.5 to 25 megacycles

RESOLUTION

10 kilocycles

TEMPERATURE RANGE

Operating — 40 to + 130° F

HUMIDITY

90% RH.

SHOCK

(Non-operating in transit case.) One 12G impact, 10 mlsec duration on each face. One 37G impact, 10 mlsec duration on each face.

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

Call The Lavoie Representative nearest you for complete information on The L A 17 Spectrum Analyzer and other Lavoie equipment.

Albany, New York
J. A. Reagan Co.
51 Summit Avenue
Phone: 4-7676

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374 Hascall Road, N.W.
Phone: Exchange 7801

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Thomas L. Taylor
2100 St. Paul Street
Phone: Belmont 5-9126

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Phone: Columbus 1-2227

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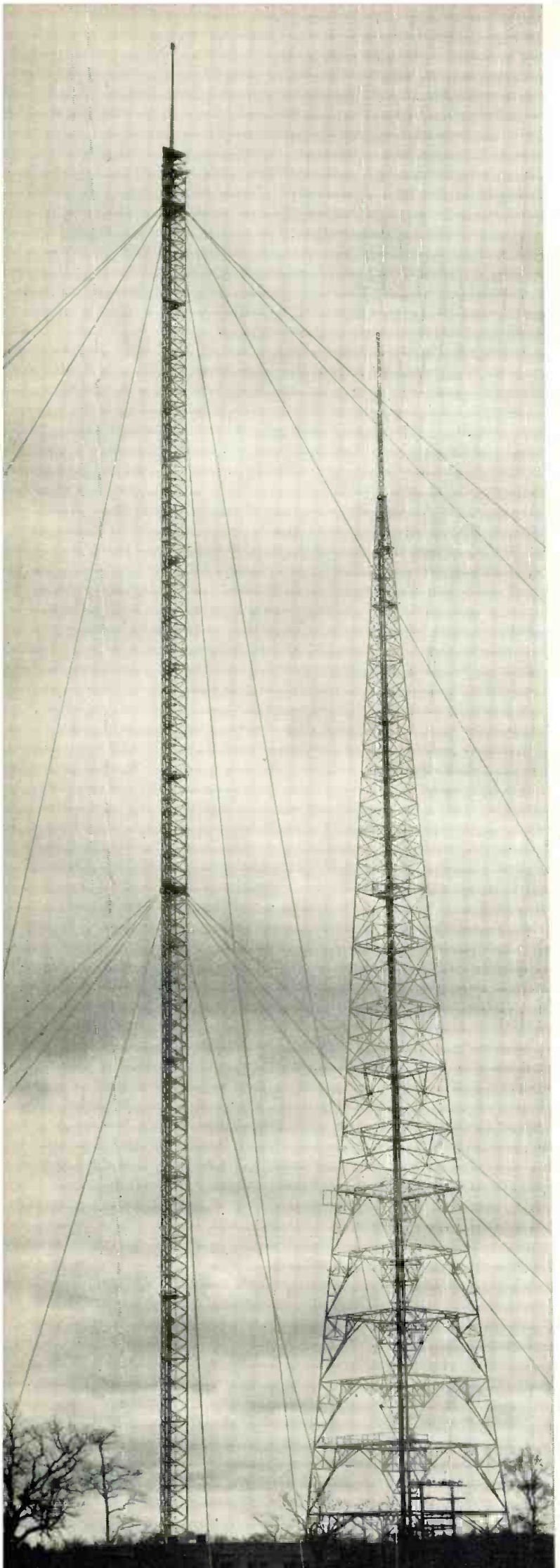


new BLAW-KNOX tower for WJAR-TV

. . specially designed for combinations of graduated and variable wind loads

This 786 foot guyed, pivoted base, type TG television tower was designed and fabricated by Blaw-Knox . . . to special specifications drawn up by the structural consultant of WJAR, Providence, Rhode Island.

WJAR's new tower has nine permanent prestressed guys, spaced at 40° intervals, at each of two levels. Of unusually rugged construction, it is designed to withstand combinations of graduated and variable wind loads.

The 786 foot guyed tower provides the additional height desired for greater extended coverage by WJAR-TV . . . as compared with the 450 foot self-supporting Blaw-Knox type H40 tower formerly used by WJAR. This self-supporting tower, incidentally, has stood firm against all hurricanes since it was erected in 1947.

The advanced design and fabrication of WJAR's new tower typifies the kind of design and fabrication service which Blaw-Knox offers you . . . to meet *your* specific requirements.

To get complete information on all types of Blaw-Knox Antenna Towers, write for your copy of Bulletin No. 2417. Or send us your inquiry for prompt service, specifying height of tower and type of antenna.

BLAW-KNOX

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
PITTSBURGH 38, PENNSYLVANIA

ANTENNA TOWERS

Distributed by GraybaR

Guyed and self-supporting—for AM • FM
TV • radar • microwave • communications

1. POTENT POWER + **2. SMALL SIZE**

Up to 5100 mmf at 300 vDCw
Up to 3900 mmf at 500 vDCw

(size) Length 3/4", average Width 7/16", average Thickness 3/16" DM-20 shown actual size

El-Menco Dur-Mica DM-20

DIPPED MICA CAPACITOR WITH PARALLEL LEADS

3. PEAK PERFORMANCE

ideal for new miniatured designs and printed wiring circuits

MEETS ALL HUMIDITY, TEMPERATURE AND ELECTRICAL REQUIREMENTS OF MIL-C-5 Specifications!

TEST IT AND COMPARE!

- El-Menco's Dur-Mica DM20 costs even less than our famous molded mica capacitors.
- Provides greater versatility — wider applications.
- Tougher phenolic casing assures *longer-life* and *greater stability* through wide ranges in temperature.
- Parallel leads simplify application in transistor and sub-miniature electronic equipment including printed circuits for military and civilian use.

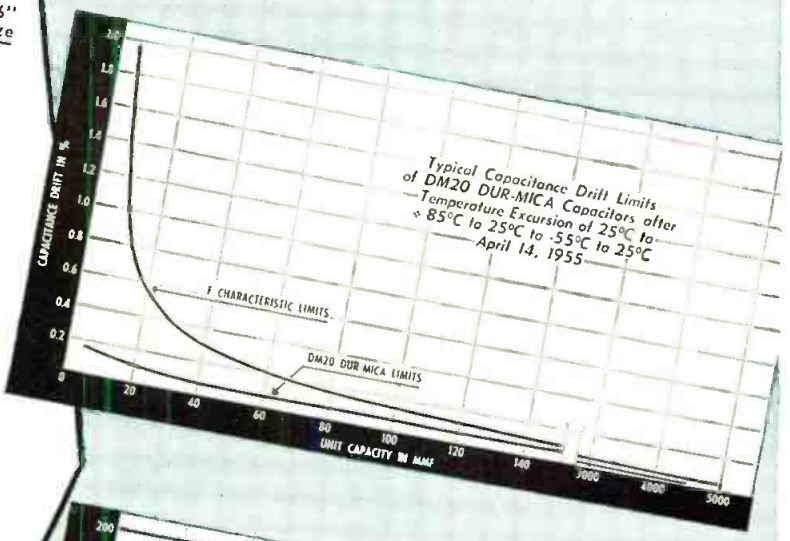
For Extreme Miniaturization Use Our DM15

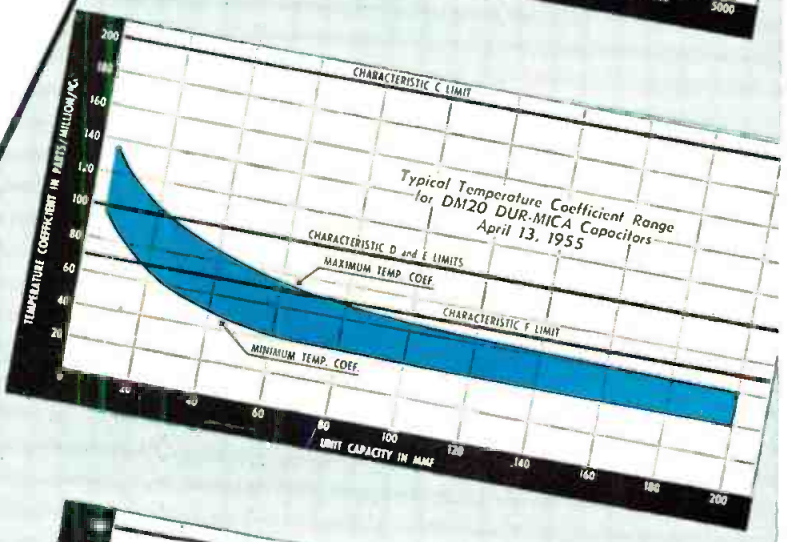
DM15 — Up to 510 mmf at 300 vDCw
Up to 400 mmf at 500 vDCw

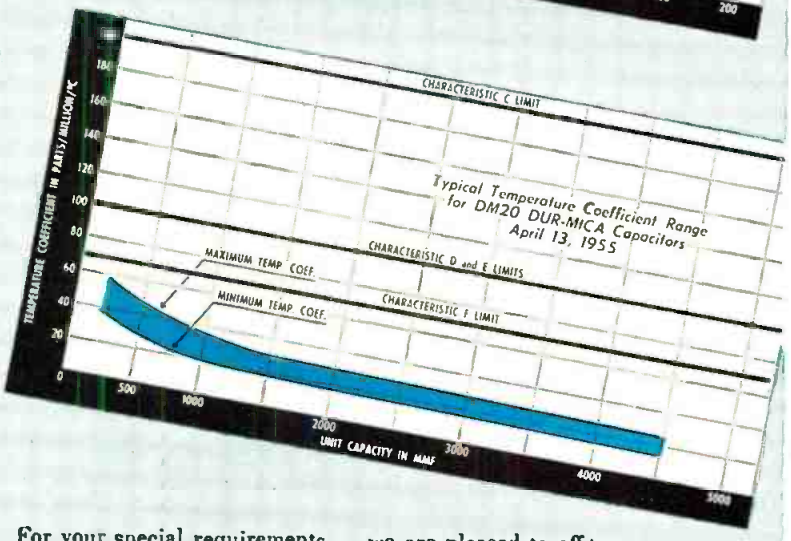
Available in 125°C operating temperature. Minimum capacity tolerance available ±½% or 0.5 mmf (whichever is greater).

El-Menco Capacitors

to meet modern miniature requirements







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• molded mica • mica trimmer
• tubular paper • ceramic

Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.
Exclusive Supplier To Jobbers and Dealers in the U.S. and Canada

NEW HIGH STANDARDS OF CAMERA-TUBE PRODUCTION

Extreme delicacy in processing parts for G-E camera tubes is shown as this glass technician fabricates an image-orthicon target. The glass bubble she holds is only 1/10,000 inch thick. After cutting out a small section, she seals this carefully to a metal ring. Any slip or other false movement would completely ruin the fragile target.

Without aid from magnification, the human eye cannot see the openings (250,000 to a square inch) in this copper mesh for a G-E image orthicon—shown here being welded to its ring. Note the rubber finger cots used by the General Electric worker, to avoid contaminating the silk-fine mesh!

Target and mesh are assembled, then riveted together with a spacing of 1/500 inch, to form a link between optical image and electrical signal. A single dust particle could mar tube performance; so before work starts, these G-E specialists sit quietly for ten minutes, to permit any dust to settle that may remain in the air after filtering and conditioning.

18-inch offset screwdrivers are used to tighten the set-screws holding target and mesh assembly in place in the camera tube. Skill, care, and time are needed to complete the delicate operation. Again, dust and lint are barred. An important step toward cleanliness, is the lint-free Nylon garments worn by all persons in the G-E camera-tube area.

CRAFTSMANSHIP FEATURE BY GENERAL ELECTRIC!

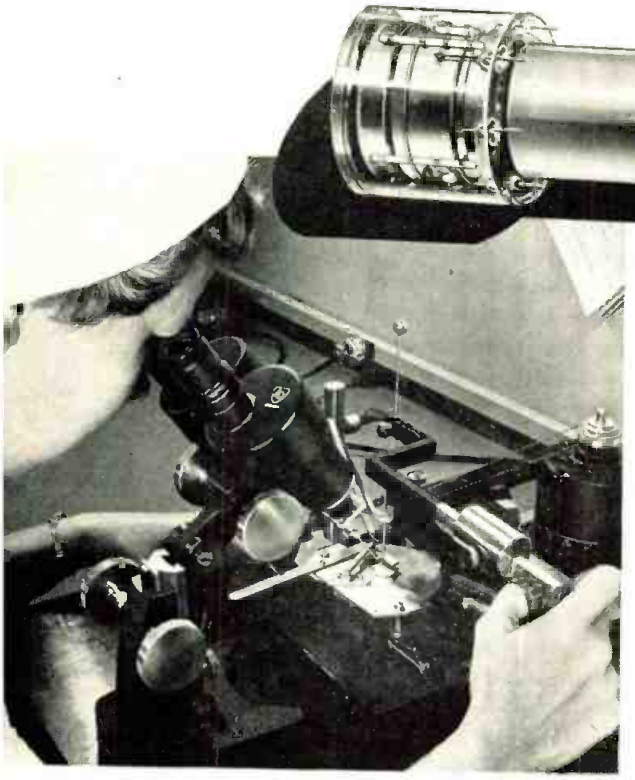
To include image orthicons, vidicons, other commercial and military types.

G.E.'s entry into camera-tube manufacture is a project of major proportions. Extensive facilities and advanced equipment have been acquired; impressive engineering and technical skills have been assembled; workers have been exhaustively trained.

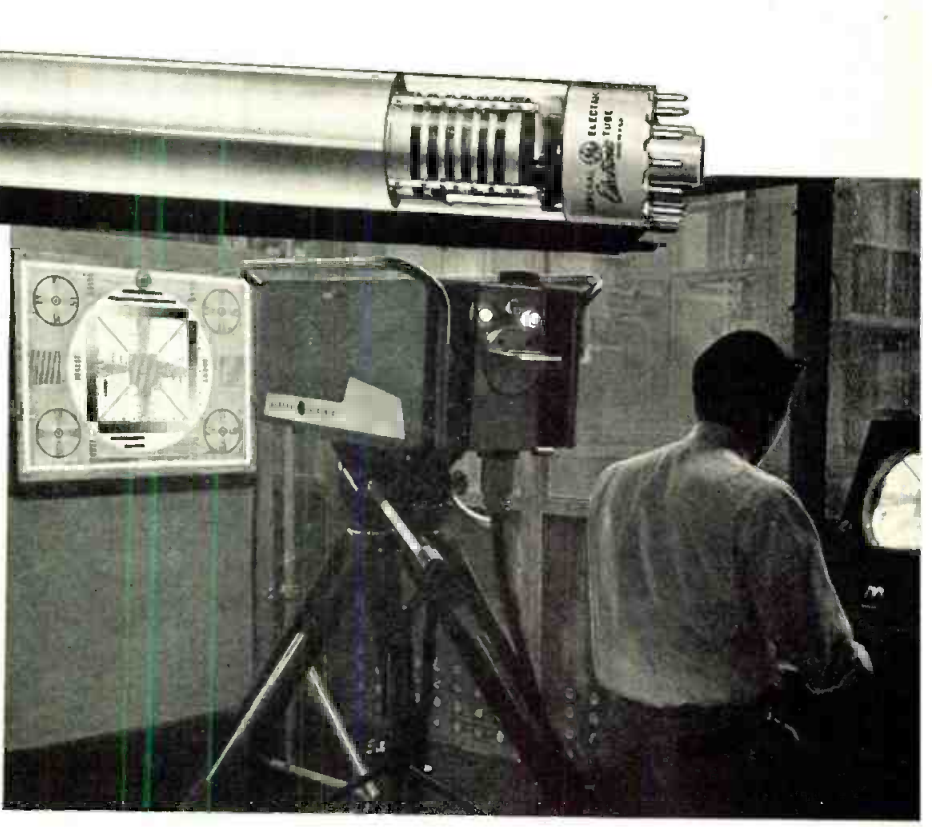
The purpose is high-quality, long-life camera tubes *of all types*—from TV image orthicons, now in full G-E production, to vidicons and other "seeing" tubes for commercial and military uses.

How improved performance is built into G-E camera tubes, these pictures show in part. Every operation described is rivalled by numerous others that call for the same or greater precision.

You are invited to familiarize yourself with G-E camera-tube manufacture, by written request for information. Problems involving camera tubes to meet your special design needs, will be welcomed. *Tube Dept., General Electric Co., Schenectady 5, N. Y.*



Powerful lenses aid trained hands. In building G-E camera tubes, numerous precision operations call for the aid of microscopes. Here a micro-drill operator drills a 1/500-inch hole—less than the diameter of a hair—for the beam-limiting aperture in the first dynode of a G-E image orthicon tube.



Final testing of a G-E image orthicon uses actual performance as the yardstick. Instrumentation supplements the verdict of the inspector's critical eyes. Life tests, under the most unfavorable conditions, also are regularly conducted by General Electric, to increase the service life and improve the performance of all G-E camera tubes . . . Above: a G-E image orthicon—Type GL-5820—ready for the TV camera.

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1B4

TELE-TIPS

(Continued from page 26)

battlefield illumination or "artificial moonlight" for combat operations. Battlefield illumination was quite successful in Korea where Army units used them 5,000-10,000 yards behind the area they wanted and directing the beams at low elevation.

ELECTRONEGATIVE MATERIAL, perfluoro-cyclic ether, is one of the newest insulating materials in use in the electrical industry. It has currently been adapted by the Westinghouse X-Ray Division in Baltimore for use in image amplifier tubes. The latter is basically a light amplifier tube which takes very dim fluoroscopic images at one end and transforms them into bright images (200-400 times) at the other end. The ether, in combinations with nitrogen and air tries to capture any free electrons moving about in the gas. Since corona is formed by free electron and ion movement, higher voltages are necessary to form corona in this gas.

NEW TEST SOCKET assembly, that combines vibration testing and short-circuit testing into one operation, won the highest company award for employee suggestions in 33 years. Russell M. Wallace and James L. Miles engineered the device for General Electric's Tube Department. They received $2620.00.

WIRING DIAGRAMS are now being printed on pressure sensitive tape. Affixing these to equipment instead of gluing saves time in manufacture and avoid the "loss" problem that can be encountered if the diagrams are shipped separately. Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N. Y., has samples printed on both acetate film and flatback pressure sensitive tape.

ULTRASONIC CLEANING of motor and generator armatures and field poles in a water-detergent solution for five minutes, is yielding remarkable results over previously employed methods. TWA will effect savings of about $14,000 during the first year of utilizing the new maintenance equipment, according to recent announcement by Bendix Aviation Corp., manufacturers.

help yourself to more dollars worth of quiet

specify the new, small

RAYTHEON

2N133 low noise TRANSISTOR

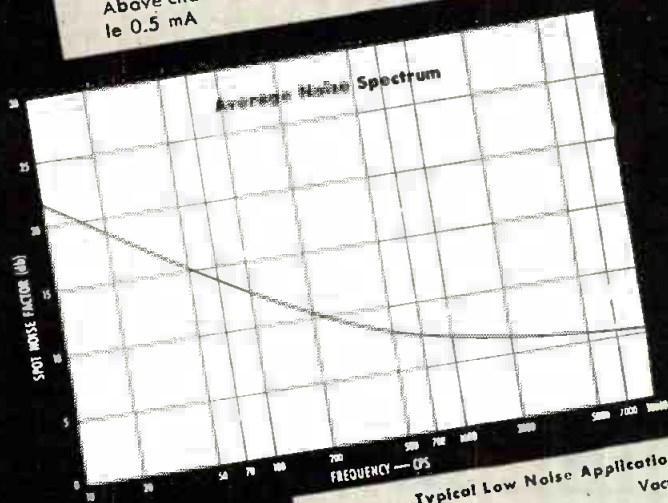
First of a new series of Raytheon hermetically sealed transistors, the 2N133 is the smallest yet — ⅓ to ¼ the size of the CK727 it replaces — and as *low* in noise as they come.

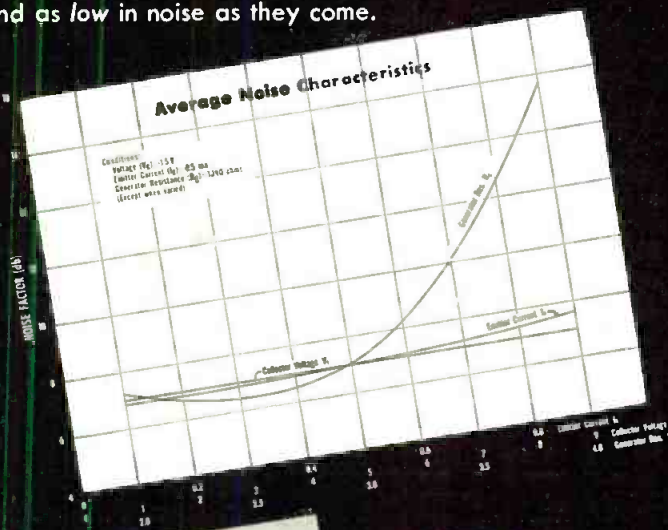
Type 2N133

Important Characteristics—Grounded Emitter (30°C)

Current Amplification Factor (Ave.)	50
Power Gain* (Ave.)	38db
Noise Factor† (Ave.)	6.5db
Noise Factor† (Max.)	10db

*Source: 1000 ohms; Load: 20,000 ohms
†In a one-cycle band at 1000 cycles
Above characteristics obtained with Vc —1.5 volts; Ie 0.5 mA

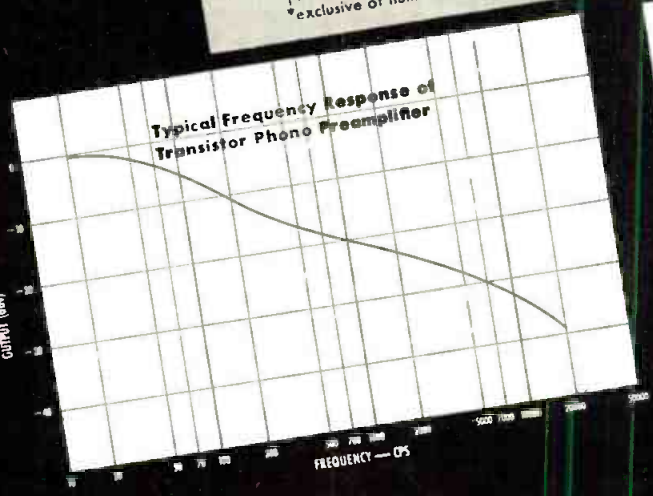


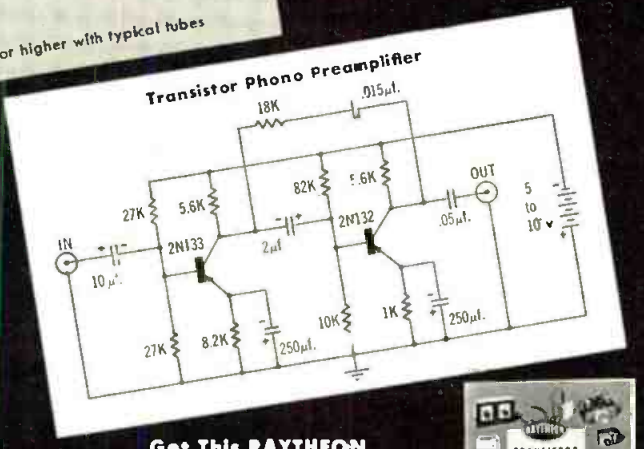


Typical Low Noise Application PHONO PRE-AMPLIFIER

	Vacuum Tube	Transistor
No. of Stages	2	2
Type of Response	RIAA	RIAA
Gain (1KC)	32db	44db
Tube	1: 6SC7	
Transistors		1: 2N133 1: 2N132
Signal Output†	0.4v	1.6v
Noise Output	100 μv*	200 μv
S/N	72db	78db

†10 millivolt signal from reluctance cartridge
*exclusive of hum which may average 500 μv or higher with typical tubes





Get This RAYTHEON TRANSISTOR APPLICATION BOOK!

116 pages — over 50 practical circuits including timers, receivers, oscillators, etc. all using low cost Raytheon Transistors. For your copy send 50¢ to Dept. P13, Raytheon Mfg. Co., Newton 58, Mass.

RAYTHEON TRANSISTORS

more in use than all other makes combined

BOOKS

Handbook of Piezoelectric Crystals for Radio Equipment Designers

By John P. Buchanan, Philco Corporation. Published Dec. 1954, by Wright Air Development Center, TR 54-248, PB111586. 591 pages, price $6.00.

The purpose and scope of this manual is to provide the design and developmental engineer of military electronic equipment with a reference handbook containing background material, circuit theory, and component data related to the application of piezoelectric crystals for the control of radio frequencies. Composed in the manual are the following sections: I. General Information; II. Crystal Units; III. Crystal Holders; IV. Crystal Ovens; V. Index. Section I contains discussions covering the theory and physical properties of piezoelectric crystals, detailed discussions of the equivalent electrical parameters and performance characteristics of crystal units, and other paragraphs on crystals and crystal oscillators. Sections II, III, and IV provide the technical and logistical data, and information concerning the application of the crystal units, crystal holders, and crystal ovens currently recommended for use in equipments of new design. Section V provides an alphabetical index for ready reference to all subjects.

Glass Reinforced Plastics

By Phillip Morgan, M.A. Published 1954, by Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y. 248 pages, price $10.00.

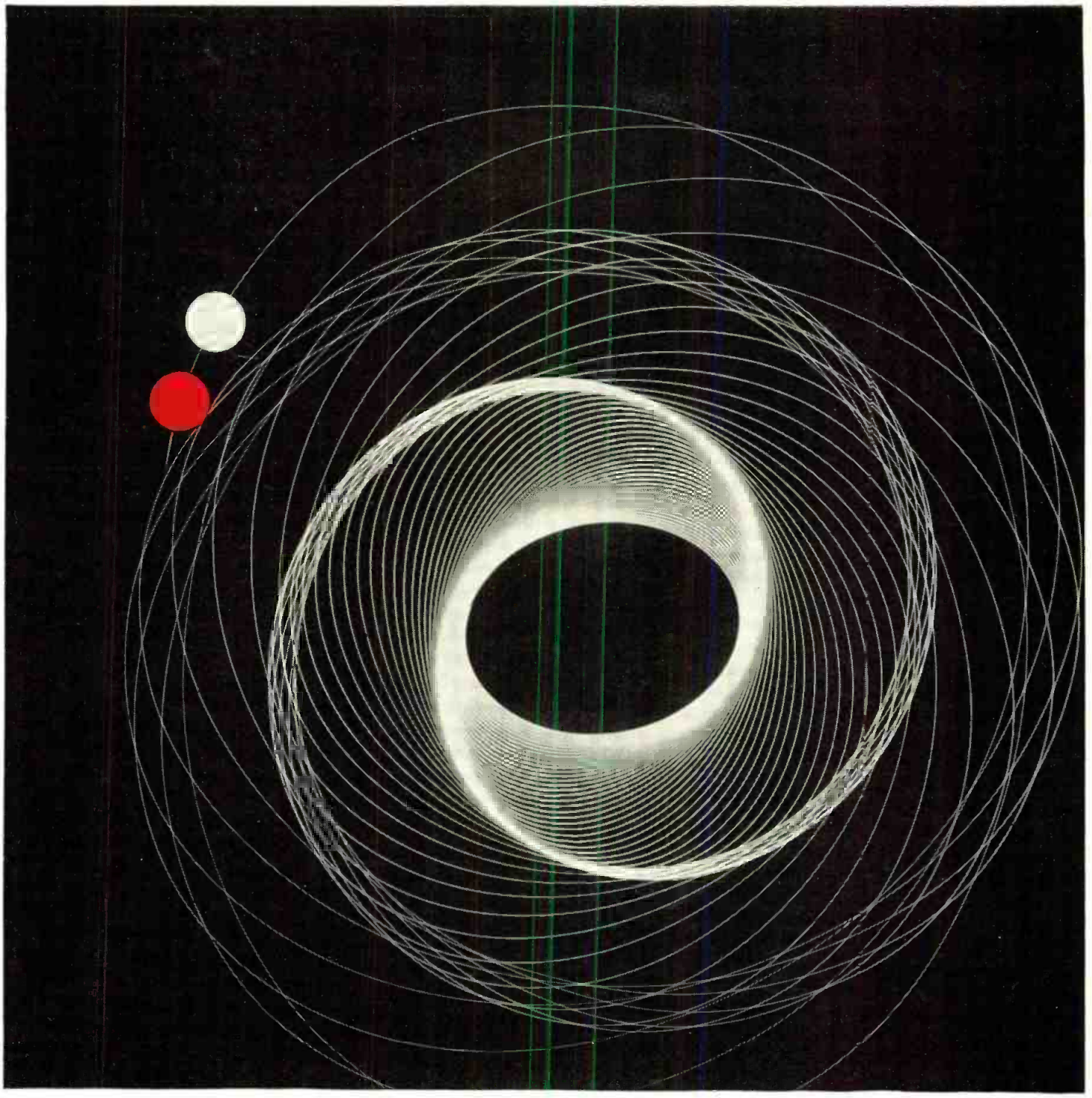
This work was written because of the great amount of interest shown during the last few years in glass reinforced plastics. A proper study of this field involves organic chemistry, design moulding processes, and the major applications; thusly, the essential facts in this volume are explained in sufficient detail for the specialist. Polyesters, being most widely employed, are dealt with in detail. Properties of the laminates especially electrical laminates, commercial moulding processes, mass-production methods, and the manufacture of tube and rod are fully covered by separate chapters. Each of the major fields of application, the automobile, aircraft, and boat-building industries, is given detailed treatment and a chapter on end-uses not contained in the fields named is another feature covered in detail.

Convegno Di Elettronica E Televisione.

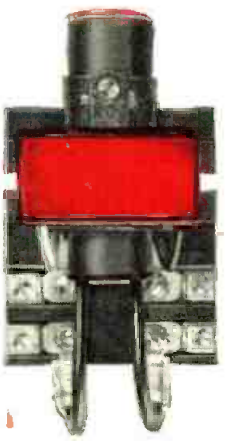
Milano, 12-17 Aprile 1954. Roma-Consiglio Nazionale Della Ricerche, 1955. 2 Volumes.

These two volumes concern the proceedings of the 4th session of the "Science Days"—Symposium on Electronics and Television, held in Milan, April 1954. They are written in four languages, Italian, French, English, and

(*Continued on page* 38)



If you control movement of machines, traffic or materials, it'll pay you to use



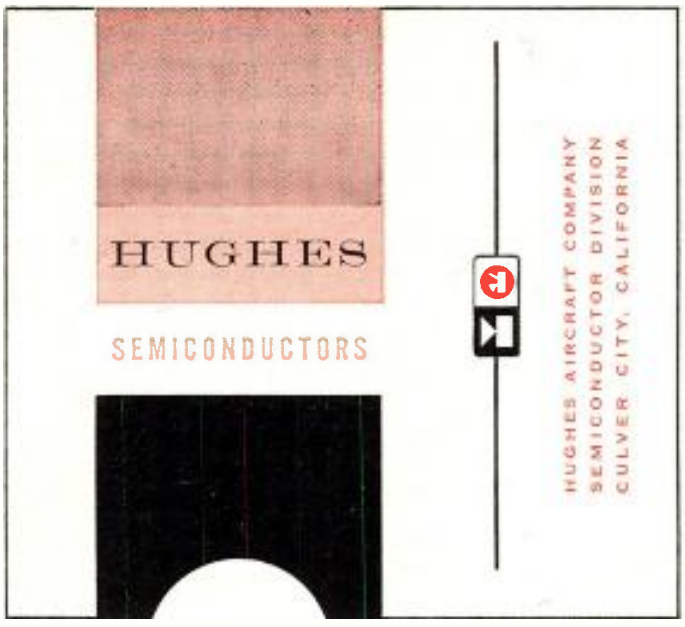
Adlake mercury relays

The new Adlake Mighty Midget relay, like *all* Adlake relays, requires no maintenance whatever... is quiet and chatterless... free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect its operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Write for catalog and information.

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago
the *original* and largest manufacturers of mercury plunger-type relays

Adlake 98th year

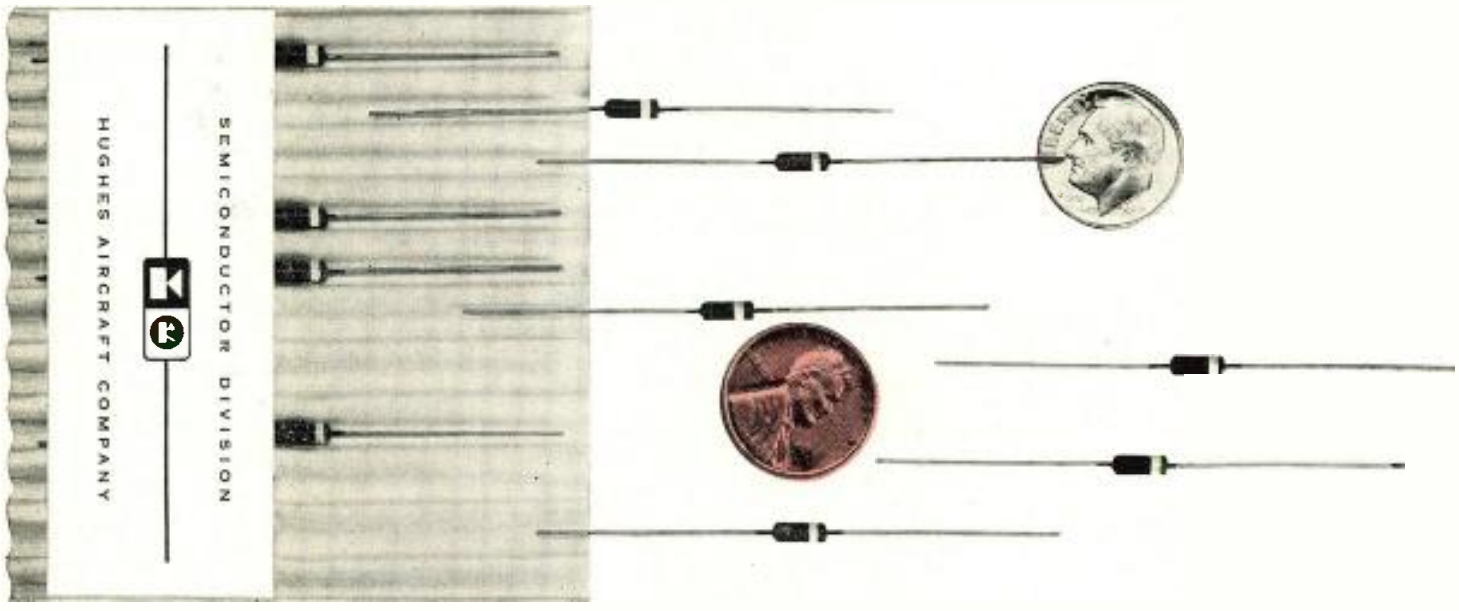


Highest

quality...

reliability...

HUGHES SILICON JUNCTION DIODES



Actual Size

features:

HIGH TEMPERATURE OPERATION*
EXTREMELY HIGH BACK RESISTANCE
VERY SHARP BACK VOLTAGE BREAKDOWN
NO VOLTAGE DERATING AT HIGH TEMPERATURE
EXCEPTIONALLY STABLE CHARACTERISTICS
ONE-PIECE, FUSION-SEALED GLASS BODY
AXIAL LEADS FOR EASY MOUNTING
SUBMINIATURE SIZE**

The one-piece, fusion-sealed glass body is impervious to penetration by moisture or other external contamination—*ensures* electrical and mechanical stability. Shipments—*in quantity*—of all types of Hughes Silicon Junction Diodes are now being made in new, compact volume packaging. When your circuit requirements call for diodes with high temperature or high back resistance characteristics, be sure to specify Hughes Silicon Junction Diodes. They are first of all—for RELIABILITY. Listed and described in Bulletin SP4.

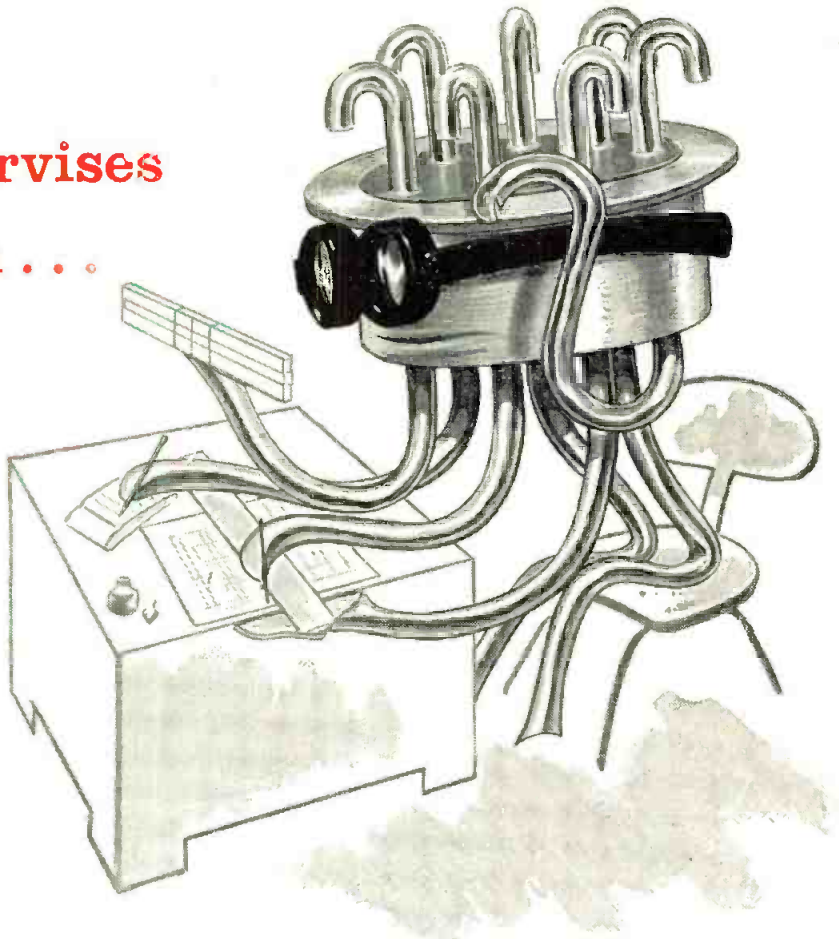
*Characteristics rated at 25° C and at 150° C. Ambient operating range, −80° C to +200° C.
**Actual dimensions, diode glass body—Length: 0.265-inch, max. Diameter: 0.105-inch, max.

HUGHES SEMICONDUCTOR DIVISION

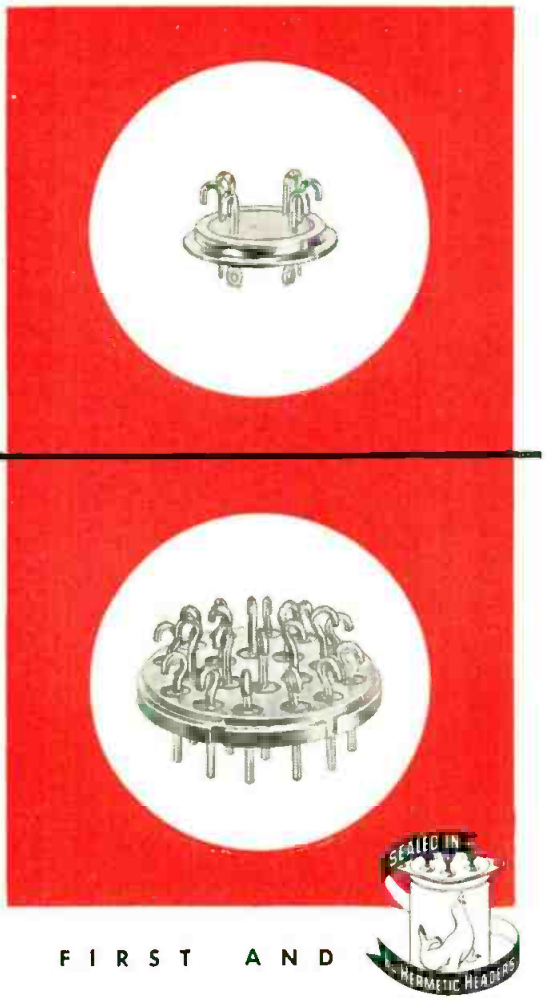
Aircraft Company, Culver City, California

New York Chicago Los Angeles

Our Mr. Smith supervises Multi-Header design . . .



the most versatile glass-metal seal



Constant Multi-Header design development enables Hermetic to offer a Vac-Tite* Compression Multi-Header to suit every design and application requirement.

If requirements call for *4 to 28* solid or tubular terminal Multi-Headers with O.D.'s that range from .375 to 1.125 diameters, Hermetic Headers of "all-glass" or "individual-glass" construction can be supplied. However, to meet the most difficult specifications, Hermetic can provide Multi-Headers *as large as you specify with as many terminations as is required* in "individual-glass" construction and solid metal body.

Consult Hermetic for standard, as well as specially designed headers, with or without mounting studs, that act as cover and seal.

Write for your new addition to "Encyclopedia Hermetica" ...a 16 page catalog containing the most diversified selection of Multi-Headers ever offered.

*VAC-TITE is Hermetic's new vacuum-proof, compression construction, glass-to-metal seal.

Hermetic Seal Products Company

33 South Sixth Street, Newark 7, New Jersey

California Associate: Glass-Solder Engineering, Pasadena

FIRST AND FOREMOST IN MINIATURIZATION

BOOKS

(Continued from page 34)

German in such a manner as to be easily comprehended by all. The author of each particular lecture discussion has his story written in the language he has chosen, and the summaries are given at the end of each paragraph in the other three languages. The volumes are filled with discussions on such topics as Connecting Systems for Television Broadcasts, Magnetic Materials, Dielectric Materials, Transistors, Semi-Conductor Materials, Electron Optics and Electron Tubes, Radar, Industrial Electronics, Servo-Mechanisms, Electronic Digital Computers, and scores of others which should be of extreme interest and value to all engineers and scientists concerned with the electronic field.

Elements of Electronics

By Henry V. Hickey and William M. Villines. Published 1955, by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y.

This is the first new text in basic electronics to be published within the last few years and is an excellent refresher course for engineers in the field. Containing a minimum of unnecessary data and a maximum of practical information, the authors cover basic electricity and electronics. Carefully integrated with each topic are the mathematics and physics essential to the study of electronics at this level. Chapters on Electromagnetism and Magnetic Circuits, Vectors and Phase Relationships, Parallel-Resonant Circuits, Voltage Doublers and Bridge Rectifiers, Tetrodes and Pentodes, Amplifier Circuits, Transistors, and many others (50 in all) are filled with useful information, photographs, and data acquired by the authors over a period of years.

Books Received

Ferroelectrics of Barium Titanate Type

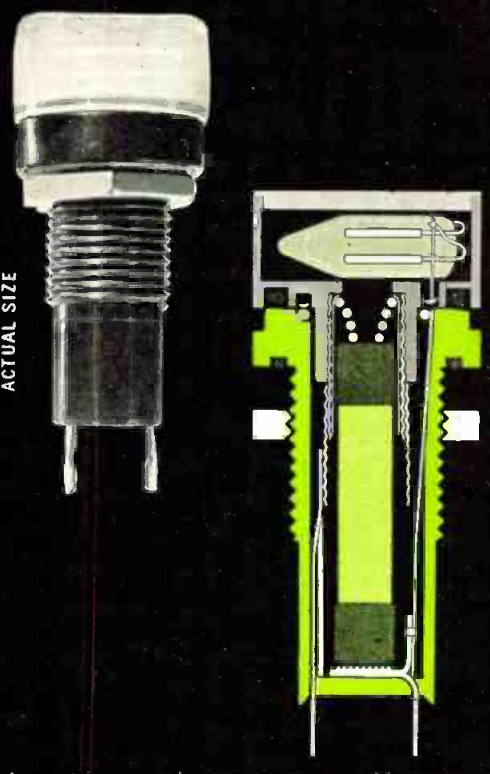
A Bibliography. U.S. Naval Ordance Test Station, Inyokern, Calif. April 1952. 83 pages. (Order PB 111550 from OTS. U.S. Dept. of Commerce, Wash. 25, D.C., price $2.25)

Research Investigation Pertaining to Low Frequency Contouring of AT-Cut Quartz Plates.

Radio Corp. of America for Army Signal Corps, Jan. 1951-Jan. 1953. 84 pages. (Order PB 111623 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.25.) Investigation Into Effects of Radiation on the Physical Properties of Quartz. Dept. of Mineralogy, Harvard Univ., for Army Signal Corps, July 1951-July 1953. 52 pages. (Order PB 111628 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $1.50.)

Proceedings of the Eastern Joint Computer Conference

Published by the American Institute of Electrical Engineers, 33 West 39th St., New York 18, N.Y. for the Joint Computer Committee. Price $3.00. Copies may also be purchased from the Association for Computing Machinery 2 E. 63d St., New York 21, N.Y. and the IRE, 1 E. 79th St., New York 21, N.Y.



NEW INDICATING FUSE POSTS

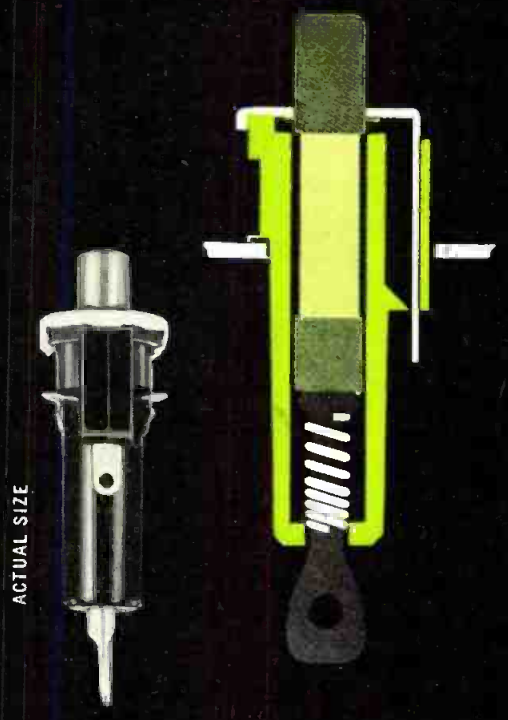
for 3AB & 3AG FUSES

Fulfilling a wide need for a fuse post which indicates by means of a light when a fuse is blown, Littelfuse has developed a line of indicating Fuse Posts in ratings up to 15 amperes and 500 volts. In normal use the indication light, located in the extractor knob, is shunted by the fuse and does not light. When the fuse blows, the open circuit voltage is thrown across the lamp which then lights, indicating that the fuse is blown.

DESIGN FEATURES

1. Smallest on the market.
2. Light is completely above panel to provide 360 degrees indication.
3. High strength bakelite body; tough translucent nylon non-breakable knob.
4. Extracts fuse with knob removal.
5. Contact pressure on fuse—5 to 8 lbs.
6. For standard commercial application a half twist bayonet knob will be used; where necessary that the unit be splash and/ or water-proof "O" rings will be added and the knob will be changed to a threaded screw type.

BURTON BROWNE ADVERTISING



NEW LIMITED CURRENT (L. C.) LINE OF FUSES AND FUSE HOLDER

Here is a completely new approach to circuit protection to completely elimin the possibility of over-fusing circuits.

This has been accomplished by a combination of three different widths bayonet locking tabs on the fuse caps.

The fuse post is made to accept only the size amperage range and t (regular or slo blo) in its range. For example: a 1 amp. slo blo fuse is 1¼" lo with .115 to .120 width tabs. The holder used with this will only accept a blo fuse (N type) above ¾ to 1¼ amps.

The holder is a ruggedly designed unit, molded from high strength bakel

It snaps into a predetermined chassis mounting hole and locks into place means of a quick snap-in type lock washer. It can be pressed into place hand or simple tools.

The fuse locks into the holder by means of a bayonet lock which permits e and quick insertion and removal of fuses.

Both solder connections are behind panel making the installation of the u simple and inexpensive.

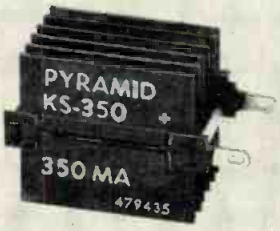
LITTELFUSE

DES PLAINES, ILL.

THE FIRST NEW DESIGN OF SELENIUM RECTIFIERS IN OVER 20 YEARS

KOOLSEL BY PYRAMID

No center mounting
Full air ventilation between plates
Light contact and constant assembly pressure
No center hot spots
Lightest weight per unit of output power
Lower initial forward resistance—better voltage regulation
Smaller overall size for each rating—cost no more
Better for all electrical and electronic equipment because of
- Improved convection cooling
- Simpler mounting
- Longer life and minimum aging
- Designed for more rugged service and rated for use in high ambient temperatures

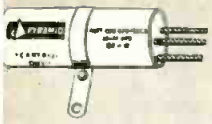


RECTIFIERS

A complete line of capacitors—electrolytics, paper, metallized paper—of the highest quality. All Pyramid capacitors are one standard made of quality materials which exceed the demands of rigid military specifications. Pyramid capacitors are used by all leading TV set manufacturers as original components and Pyramid capacitors are listed and cross-referenced in all Photo-Fact Folders.

NEW
Capacitor
Resistor-Analyzer
AND
Quick Capacitor Checker
Model CRA-1

ELECTROLYTICS


Type CDB


Type MC


Type TM


Type DO


Type TD, TDL

PAPER


Type 85LPT


Type CT

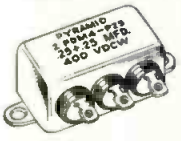

"IMP" Moldec


Type PTIM, CP 25


Type PG "Glasseal," CPO4, TOCP11


Type PEM, CP 67, CP 69


Type PKM, CP61 to CP65

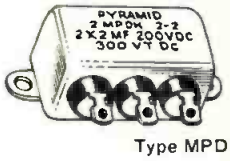

Type PDM, CP 53


Type PLMF, CP70

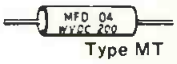

Type PJ, CP70

what is available from PYRAMID

METALLIZED PAPER



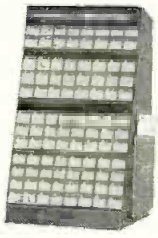
Type MPD



Type MT


Type MPG


Type MPT


PYRAMID DISPENSER

The Pyramid dispenser for counter, wall or floor has increased capacitor sales as much as three or four times in jobber stores where it has been used.

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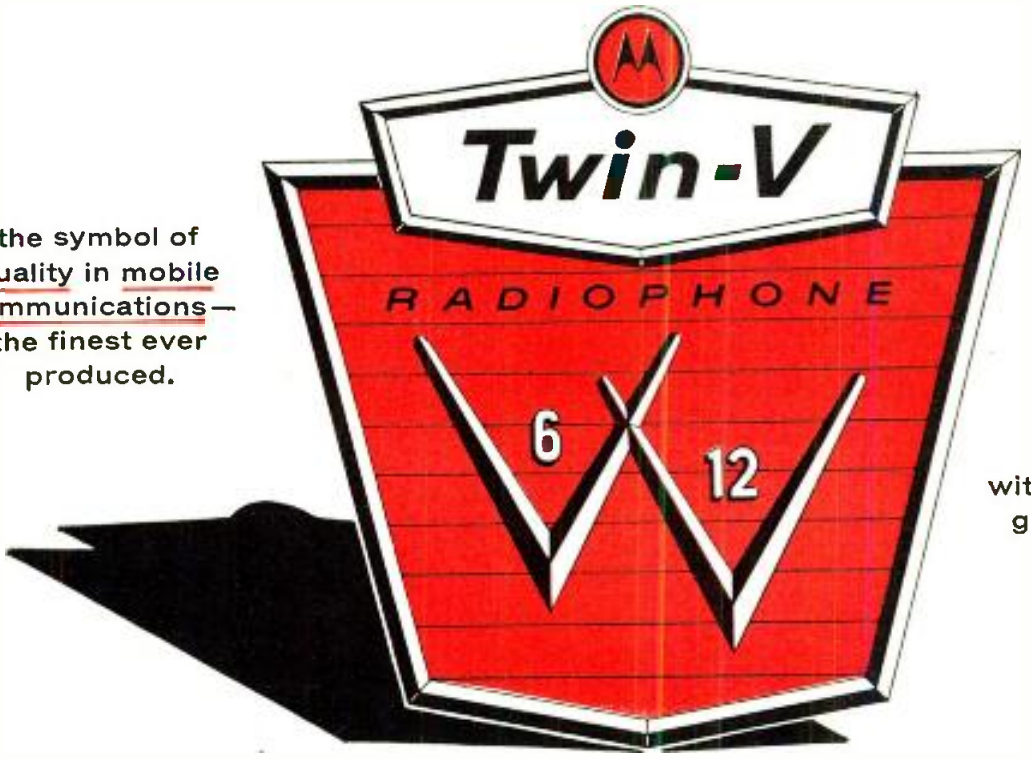
THE NEW STANDARD OF 2-WAY RADIO EXCELLENCE

the symbol of quality in mobile communications—the finest ever produced.



with built-in reliability guaranteed by the name *MOTOROLA*

Radio equipment bearing the TWIN-V trademark ASSURES YOU ESTABLISHED MOTOROLA QUALITY plus many new and exclusive advance-engineered features

NOW available—the most complete line of precision built, two-way radio models, vibrator *or* dynamotor powered . . . featuring foolproof 6/12 volt interchangeability, the solution to today's installation problems in mixed fleets of 6 and 12 volt vehicles.

There is a model designed for each and every application in the 24-54 mc., 144-174 mc., and 450-470 mc. frequency ranges, with a wide selection of transmitter power output ratings to serve your varied communications requirements. Take your choice of compact, economical, vibrator powered models or rugged, long life, dynamotor powered units to serve your specific operational needs.

These models give you improved communications range, maximum intelligibility through better receiver sensitivity—better circuitry for control of ignition noise, "hash" and other interference—better audio response for clearer, crisper voice messages that get through even under the worst conditions—better squelch operation to reliably block out nuisance noise, yet resets instantaneously to receive the weakest useable signal.

Here is equipment designed to new higher performance standards—built to last . . . built to accommodate changing operating conditions, economically and functionally . . . built to more readily accommodate conversion to split-channel conditions. All Motorola units are fully field tested, proved in use, proved for sustained peak performance, proved for minimum maintenance.

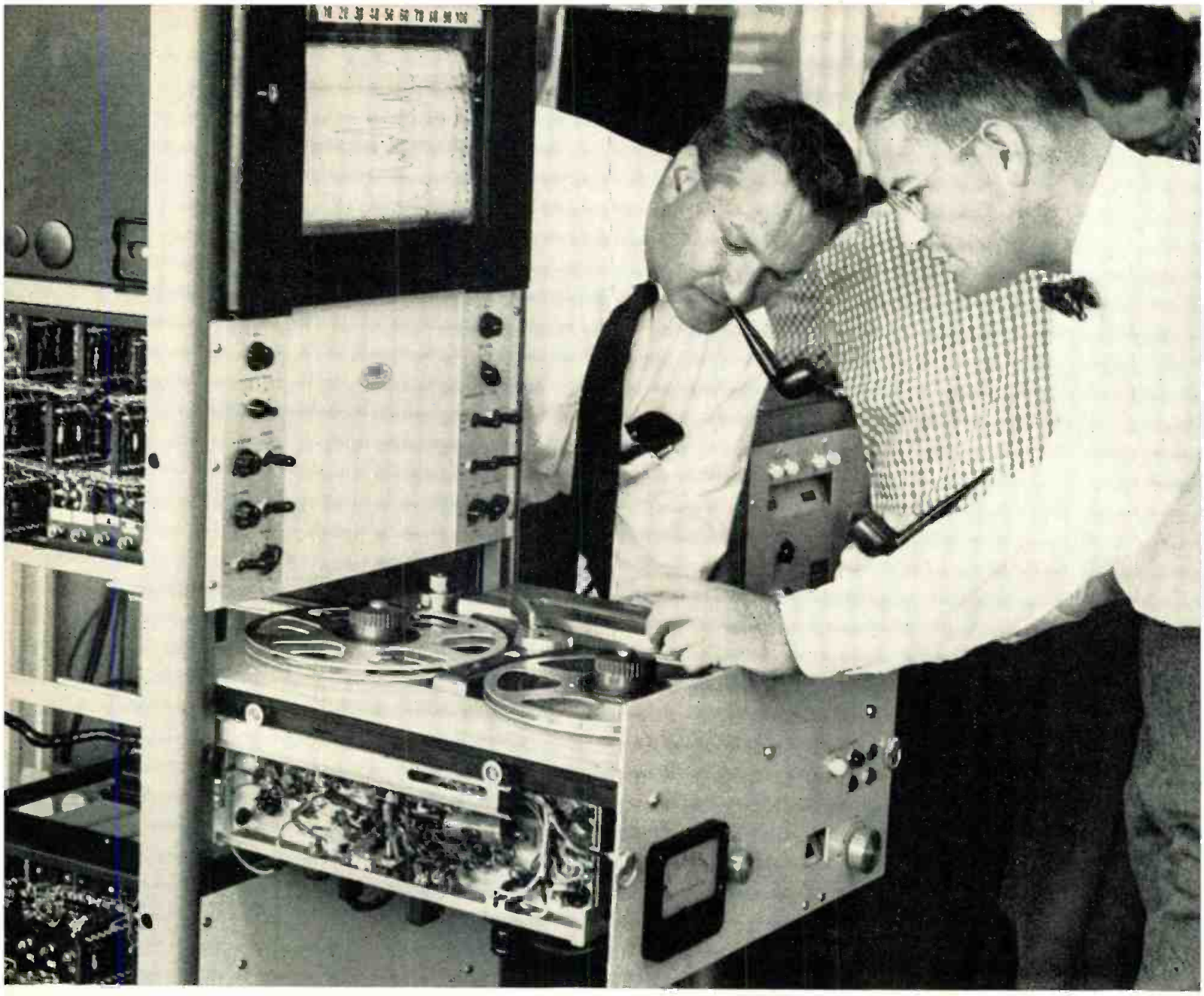
Get the complete details on the new "TWIN-V" Radiophone. A Motorola communications specialist is in your area ready to help. Phone, write or wire *today* for complete descriptive literature.

MOTOROLA

2-WAY RADIO

MOTOROLA COMMUNICATIONS & ELECTRONICS, INC.
A SUBSIDIARY OF MOTOROLA, INC.
4501 AUGUSTA BOULEVARD • CHICAGO 51, ILLINOIS
ROGERS MAJESTIC ELECTRONICS LTD., TORONTO, CANADA

Motorola consistently supplies more mobile and portable radio than all others combined.
Proof of acceptance, experience and quality.
The only COMPLETE radio communications service—specialized engineering . . . product . . . customer service . . . parts . . . installation . . . maintenance . . . finance . . . lease.
"The best costs you less—specify Motorola."



The Standard of Comparison

New engineering concepts have resulted in the Beckman Infra-Red Spectrophotometer, Model IR 3, most advanced and accurate laboratory investigation equipment of its kind ever built.

A Berlant Magnetic Tape recorder is used to "remember" slit positions and wave length values of a standardizing sample, then "play back" this information to accurately control slit width and wave length values within a limit of .001 micron. A unique Beckman development, the memory system by magnetic tape control results in an absolute analysis accuracy of ¼%, compared to the best previous of 3% from split beam comparison instruments. Lee Cahn, a chief project engineer of Beckman division, Beckman Instruments, Inc., explains the inner workings of this amazingly accurate device to Bert Berlant, president of Berlant Instruments.

The reasons why the Berlant tape recorder was chosen as the "standard of comparison" are the qualities that have made Berlant Broadcast and Berlant Automatic Recorders the most widely specified recorders for radio stations and other professional uses.

In less than a year since it was introduced, this professional recorder has won universal acceptance for highest performance and dependability. Berlant recorders feature a flexibility and versatility unmatched by any other recorder on the market, regardless of cost.

If you have a requirement for a magnetic tape recorder in the audio field, a Berlant-Concertone franchised distributor in your neighborhood is prepared to render you guaranteed satisfaction... at a comparatively low cost!

If you have a special magnetic recording requirement in instrumentation or industrial usage, call or write to Berlant *Recordata Division* for information on specialized equipment to satisfy your needs.

BERLANT INSTRUMENTS
4917 West Jefferson Boulevard
Dept. S13, Los Angeles 16, California

THIS IS NO. 4 IN A SERIES OF FIELD REPORTS.

Manufacturers of Concertone... world's foremost high fidelity recorders and accessories.

KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS are tried-and-proved remedies for almost every production situation where soldering time gets out of hand. Kester's great adaptability to widely divergent soldering requirements has time and again helped so many manufacturers combat rising production costs. It could be the solution you've been looking for!

THIS IS IT . . . *the informative 78-page free Kester textbook "SOLDER . . . Its Fundamentals and Usage." Send for your copy today!*

KESTER SOLDER COMPANY

4210 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

PERSONAL

Dr. Benjamin H. Alexander has been appointed manager of Semiconductor Operations for CBS-Hytron. He will be responsible for all semiconductor development, engineering and manufacturing, and will be located at the Lowell, Mass., plant.

B. H. Alexander

E. S. Seeley

E. S. Seeley assumed new duties as director of engineering for Altec Lansing Corp., Beverly Hills, Calif. Mr. Seeley was formerly chief engineer of Altec Service Corp. in New York.

Harold R. Terhune, manager of Standards & Components at Federal Telecommunications Laboratories, Nutley, N. J., a division of International Telephone and Telegraph Corp., has been elected a Fellow of the Standards Engineers Society.

Dr. Louis G. Dunn has been appointed director of the Guided Missile Research Division of The Ramo-Wooldridge Corp., Los Angeles, Calif.

Dr. Truman S. Gray has been named consultant on nuclear energy by the Brown Instruments Division of Minneapolis-Honeywell Regulator Co. He is associate professor of engineering electronics at Massachusetts Institute of Technology.

A. L. Riggs, Allan K. Tower, B. Walkinshaw, Harold D. Busby, John D. Determan, and **Joseph B. Ignatowicz** have all recently become members of the Field Engineering Staff of Hughes Aircraft Co., Culver City, Calif.

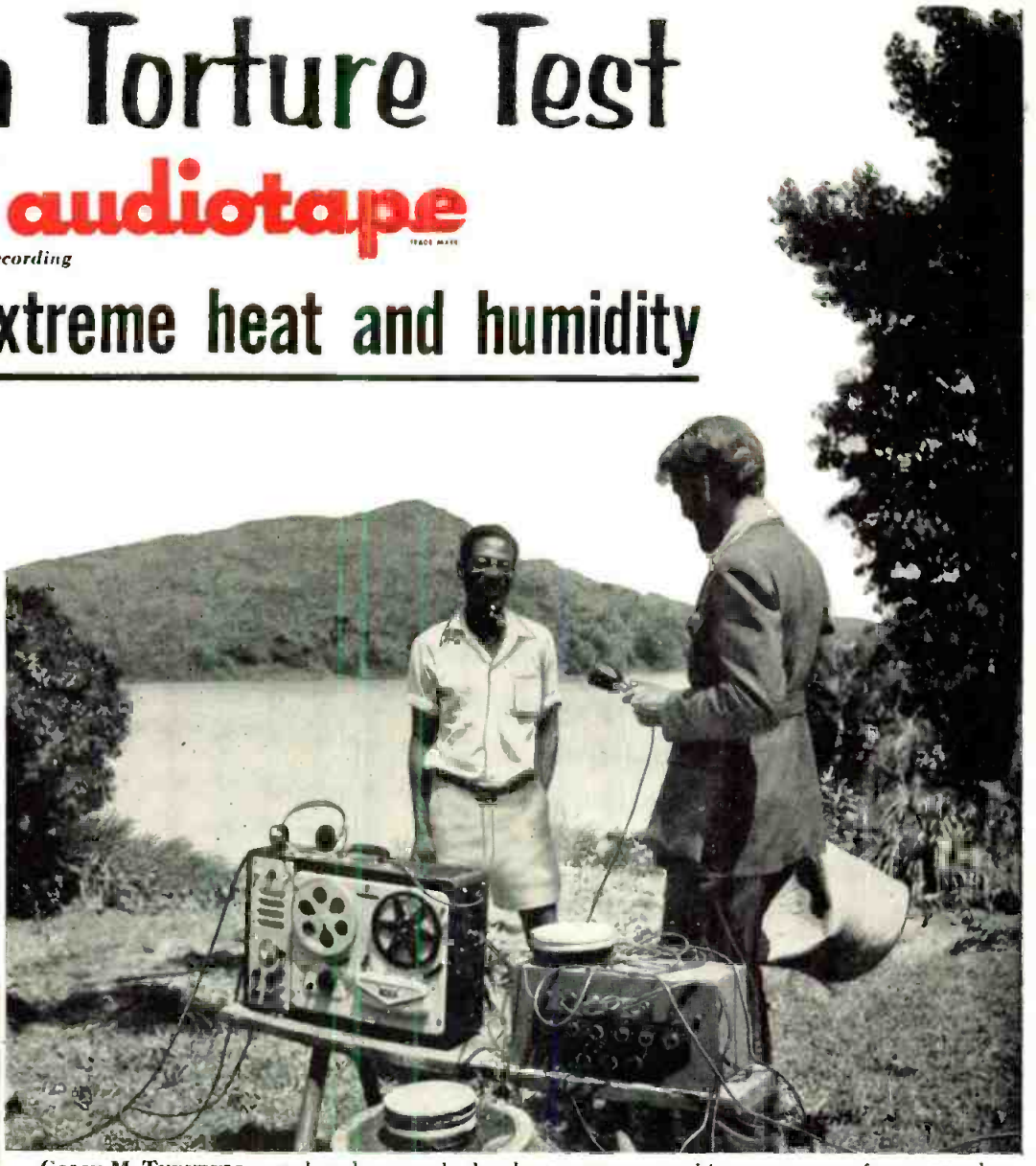
Gerald C. Schutz has been named director of electronics, **Adrian Jacobs,** administrative staff assistant, and **Erwin Kaestner,** technical staff assistant, for the Gruen Watch Co., Cincinnati, O.

Dr. Michael J. Di Toro has joined the Polytechnic Research & Development Co., Inc., of Brooklyn, N. Y., as chief electronic engineer. He will be responsible for the planned expansion into different electronic fields.

Charles D. Perrine Jr. will rejoin the staff at Convair Division of General Dynamics Corp. as assistant division manager-engineering.

Edward A. Roberts has been promoted from supervisor of electronic instrumentation to assistant manager of electrical engineering research at Armour Research Foundation of Illinois Institute of Technology, Chicago.

African Torture Test proves Longer LR Recording audiotape immune to extreme heat and humidity



"The Ituri Forest provides the worst possible conditions for recording work. Our camera lenses grew mushrooms, even on the inner surfaces. All leather molded in four days. Our acetate-base tapes became unuseable. But the LR Audiotape always unwound without sticking and showed no tendency to stretch or curl."

COLIN M. TURNBULL, noted explorer, made the above comments on his recent return from a year-long recording expedition through the arid deserts and steaming jungles of Africa, where Audiotape on "Mylar" polyester film was subjected to the "worst recording conditions in the world." Its performance speaks for itself.

Here's positive proof that all hot-weather recording problems can be entirely eliminated by using the new LR Audiotape on Mylar* polyester film.

During his trip from Morocco to East Africa, through the Gold Coast and the Congo, Mr. Turnbull recorded 45,000 ft. of Audiotape on 1 and 2 mil "Mylar". Not an inch of it gave any trouble, either in desert sun (125° temperature, 25% humidity) or in the Congo forests (85° temperature, 90% humidity).

That's a real torture test for tape and proof of the superiority of the new, longer recording Type LR Audiotape. Made on tough but thin 1-mil "Mylar", it gives you 50% more recording time per reel, yet is actually far *stronger* than 1½-mil acetate-base tape under humid conditions. For better recording in *any season*, ask your dealer for "Mylar" Audiotape—now available in 1, 1½ and 2 mil base thickness. Write or ask for a copy of Bulletin No. 211 containing complete specifications.

AUDIO DEVICES, Inc.

444 Madison Avenue, New York 22, New York
Offices in Hollywood — Chicago
Export Dept., 13 E. 40th St., N.Y. 16, N.Y., Cables "ARLAB"

Table I — TESTS AT 75°F, 50% RELATIVE HUMIDITY

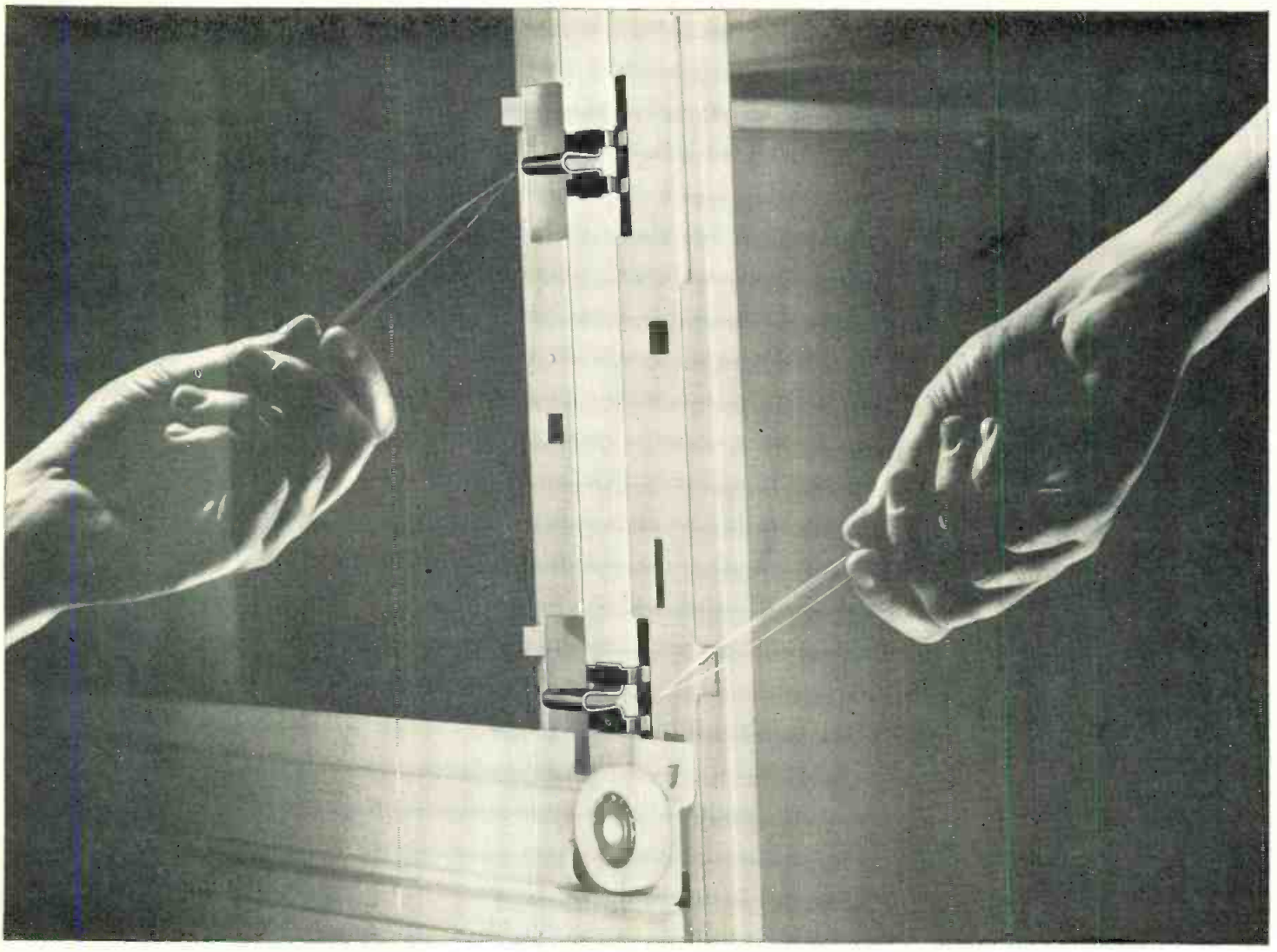
	Yield Strength	Breaking Strength
1 mil Acetate	3.7 lb.	3.9 lb.
0.9 mil "Mylar"	4.2 lb.	7.6 lb.
1.45 mil Acetate	5.0 lb.	5.5 lb.

Table II — TESTS AT 75°F, 90% RELATIVE HUMIDITY

	Yield Strength	Breaking Strength
1 mil Acetate	1.8 lb.	2.5 lb.
0.9 mil "Mylar"	4.1 lb.	7.6 lb.
1.45 mil Acetate	3.0 lb.	4.1 lb.

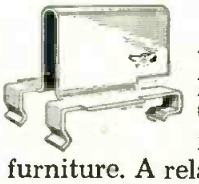
The above test data, taken under conditions of both winter and summer humidity, show the marked superiority of 1-mil "Mylar," not only over the thin cellulose acetate base, but over the standard 1.45-mil acetate as well.

*DuPont Trade Mark



Engineered by Tinnerman . . .

SPEED CLIPS® GIVE DESKS EXTRA MODEL FLEXIBILITY. . . and save money!



Here's the special SPEED CLIP that enabled the General Fireproofing Company, Youngstown, Ohio, to build maximum flexibility into its new "Generalaire" office furniture. A relatively small number of basic units can be interchanged to produce 46 different desk and table models. General Fireproofing reduces manufacturing and shipping costs; dealers have fewer parts to stock and handle!

This one-piece, spring-steel SPEED CLIP snaps easily and quickly into place by hand. It replaces a costly five-piece locking bar latch mechanism that had to be factory-installed in left- and right-hand assemblies. Now, SPEED CLIPS make it possible to ship knockdown locking bars to dealers who then build left- and right-hand assemblies from basic units to fill customers' orders. What's more, Generalaire desks are assembled throughout with 20 or more SPEED NUT brand fasteners which contribute greatly to this flexibility.

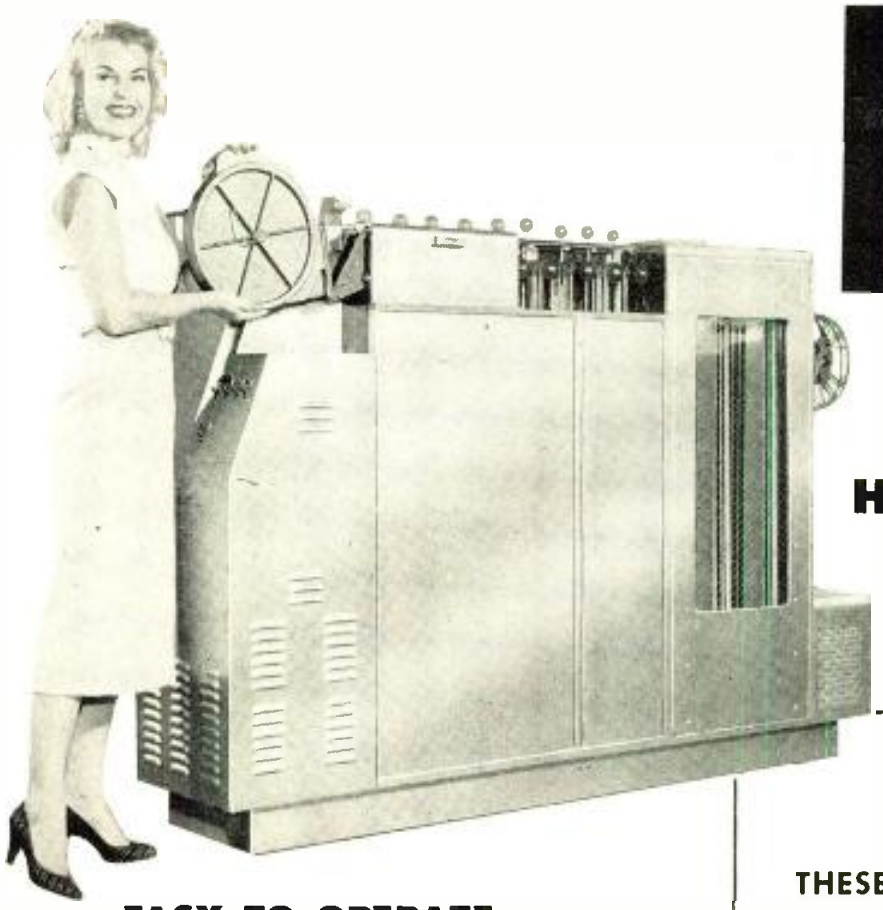
A free Tinnerman Fastening Analysis of your products may show similar assembly advantages with important production savings. See your Tinnerman representative soon and write for Fastening Analysis Service Bulletin No. 336.

TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio

Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois, (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts®

FASTEST THING IN FASTENINGS®



EASY

DOES IT!

with the new

HOUSTON FEARLESS LABMASTER

16mm Film Processor

EASY TO OPERATE

Never was there a film processor as *easy* to use as the Houston Fearless Labmaster! Fully automatic. Daylight operating. All controls grouped for maximum convenience. For 16mm b&w negative or positive film. Easily converted for reversal film or color. Famous Houston Fearless quality, produces consistently finer results.

EASY TO SERVICE

All parts of the Labmaster are easily accessible for routine servicing and maintenance.

EASY TO OWN

Priced *far* lower than *any* comparable machine! Price includes built-in air compressor, recirculation pump, loading elevator, temperature control, speed control . . . everything *complete* to plug in and operate. In comparing values, be sure to add the cost of all necessary extras to the price of other makes!

COMPARE

THESE FEATURES AND TOTAL COST WITH EVERY OTHER PROCESSOR!

- Completely self-contained no added accessories necessary to operate.
- Highest speed consistent with quality work. Variable control.
- Change magazines without stopping machine.
- Exclusive Houston Fearless Clutch Drive eliminates film breakage.
- Convertible for reversal or color film.
- Temperature control on developer and fixer.
- Recirculation on developer.
- Venturi-type air squeegee. Highly effective.
- Built-in compressor for air squeegee.
- Filtered, forced air, infrared heat in dry box.
- Hot air exhaust provided on dry box.
- Bottom drain on each solution tank.
- All parts easily accessible for service.
- Compact, "in-line" design.
- Priced far lower.

NEW! EASY FINANCE PLAN

Let your new equipment pay for itself from savings it will earn. Small initial payment. Balance up to 5 years. Low interest. Write for details.

HOUSTON FEARLESS

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"WORLD'S LARGEST MANUFACTURER OF MOTION PICTURE FILM PROCESSING AND TV STUDIO EQUIPMENT"

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Houston Fearless Div., 11805 W. Olympic Blvd., Los Angeles 64, Cal.
Send complete details on ( ) Labmaster. Other Processors:
( ) 16mm ( ) 35mm ( ) B&W ( ) Color ( ) Negative ( ) Positive
( ) Reversal ( ) Negative-Positive. ( ) Printers ( ) Scene Testers
( ) Camera Dollies ( ) Tripods ( ) Heads ( ) TV Pedestals

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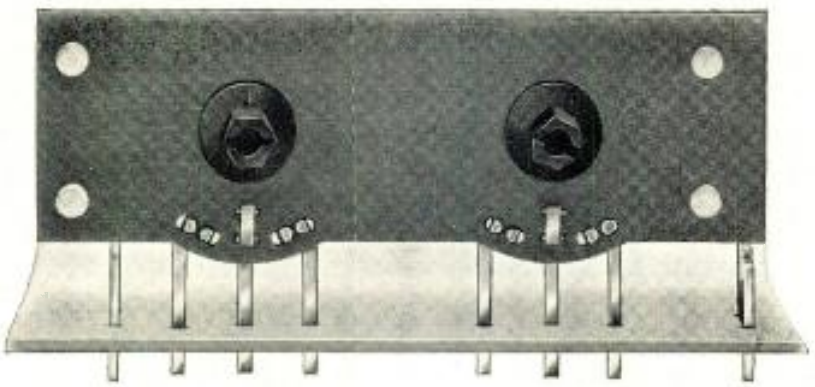
MALLORY



Strip-type Mallory carbon control adapted for quick mounting and connection on printed circuits. Strips can be mounted in tandem to take minimum space on crowded chassis.

Strip-Type Mallory Multiple Controls*

Save Space . . . Speed Assembly on Printed Circuits

Low cost way to get close tolerance fixed resistors

The economical cost of the Mallory strip-type controls makes them useful in place of close tolerance fixed resistors. Just adjust them to the exact resistance required in the circuit, and you will have a fixed carbon resistor. The stability of the specially developed carbon element assures you of highly constant resistance value.

NEW ECONOMIES in the production of printed electronic circuits are made possible by these Mallory strip-type controls. Available in single, dual and triple sections, they have straight tinned terminals which project through punched slots in the printed sheet for dip soldering.

Mounting is simple and fast. Shouldered tabs fixed to the ends of the strip hold the control assembly in place. To save space, multiple sections can be mounted about ½" behind each other. Holes punched in the strip permit the shafts of the rear section to project through the front unit for adjustment.

For conventional chassis as well as printed circuits, this functionalized design reduces a carbon control to its simplest form. The resistance wafers are mounted directly on a phenolic panel. Due to this unique construction, Mallory is able to offer multiple units at a cost substantially lower than that of a similar number of single controls.

High stability of resistance, low noise and long service life are provided by the high-density Mallory control element. A complete range of resistance values from 250 ohms to 10 megohms is available. For full data, write or call Mallory today.

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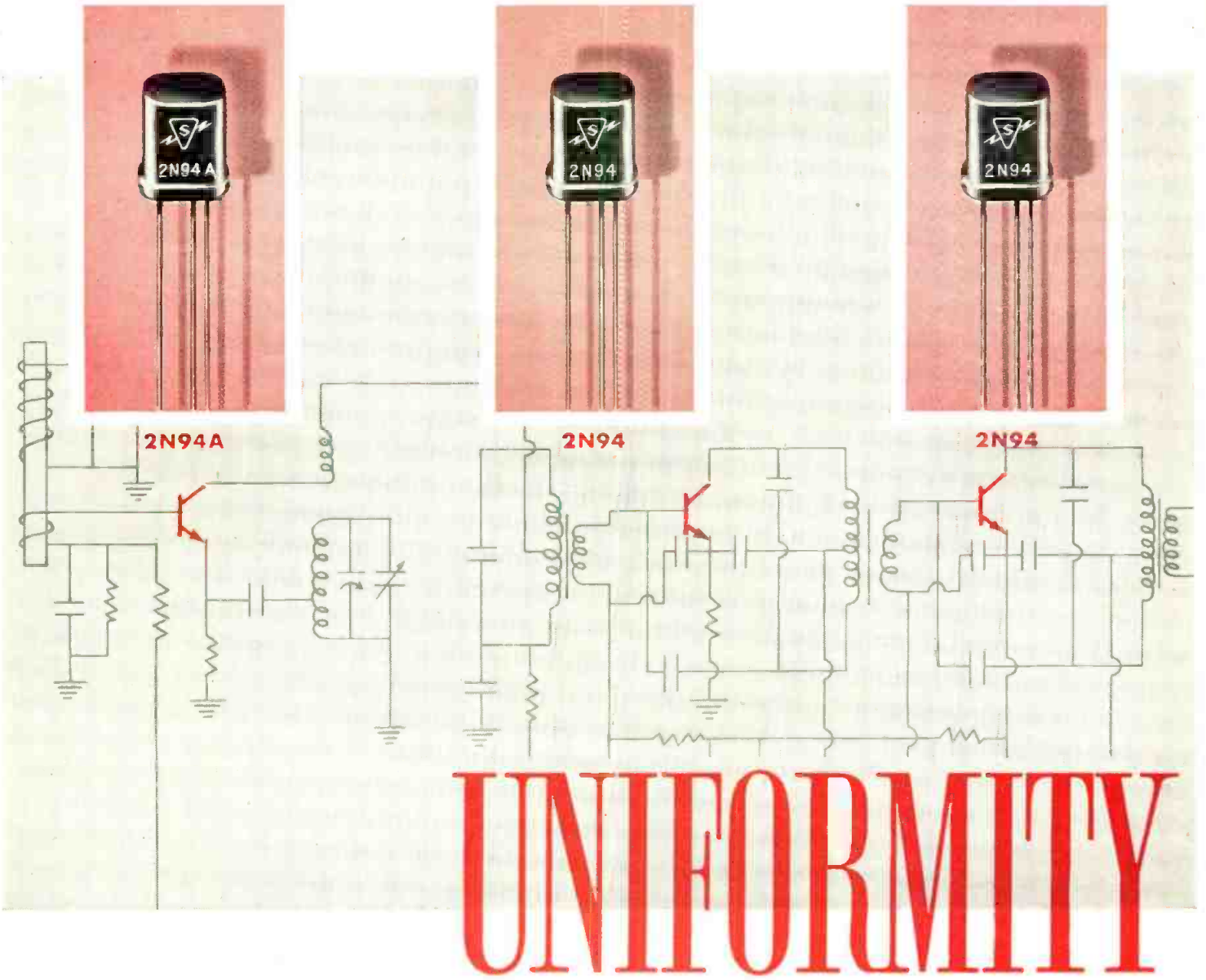

UNIFORMITY

...for more gain from stage to stage without preselecting

For your broadcast applications, Sylvania high frequency transistors Type 2N94 and 2N94A offer higher gain without preselection by stage. Production is simplified; performance is more stable; servicing problems are minimized.

Low collector capacitance and ease of neutralization account for this important advantage. In a typical broadcast application, the addition of a single 10 μμf capacitor in the collector circuit of IF and RF stages provides adequate neutralization.

Uniformity is obtained through exclusive construction techniques permitting close production control.

In computer applications Sylvania Transistors offer quick recovery time for high speed switching and provide higher gains at higher operating currents.

High Frequency Transistors
Type 2N94 (3 mc alpha cutoff)
Type 2N94A (6 mc alpha cutoff)
featuring
- high gain
- high uniformity
- low collector capacity
- ease of neutralization

Low Frequency—High Gain
Type 2N34 (PNP)
Type 2N35 (NPN)
—for low to medium power use. Gains up to 40 db in grounded emitter circuit

High Power—Low Frequency
Type 2N68 (PNP)
Type 2N95 (NPN)
—increased power ratings—to 2.5 watts. Use for high current, low voltage applications (6—24 volt power supplies)
Type 2N101 (PNP)
Type 2N102 (NPN)
Similar to types 2N68 and 2N95 without cooling fins. Power dissipation 1 watt.

For complete information on Sylvania Transistors write to Department J40R.

"Another reason why it pays to specify Sylvania"

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LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

improve printed circuit design and performance with Sprague Autocon* Capacitors

Plug Sprague Autocon capacitors into your printed wiring boards and you immediately gain greater freedom in circuit design . . . more reliable circuit performance. That's because Autocon capacitors are the first "one-ended" case paper capacitors designed to satisfy *all the special requirements* of printed wiring board assemblies.

These new capacitors are enclosed in a pre-molded cylindrical shell of non-flammable thermosetting plastic, with the capacitor section securely sealed against the entry of moisture by a plastic resin endseal bonded to the phenolic housing. The two short straight leads which issue from the endseal are held at a closely controlled distance from each other.

An index key molded in the phenolic housing adjacent to the outside foil lead facilitates identification of the lead for automatic insertion machinery or hand operators. In addition, three stand-off feet raise the endseal and shell proper above the printed wiring board, avoiding moisture and dust trap formed by capacitors with a flat circumference on the housing. The feet also permit use of double-sided wiring boards without causing low resistance shorts between top side conductors through accumulated dust around the circumference of the capacitor.

The new Type 89P Autocon capacitors are of the solid dielectric type, and are impregnated with HCX,* a new and exclusive Sprague development. This hydrocarbon material has superior insulation resistance, lower power factor, and flatter capacitance change vs. temperature characteristics than polyester solid-dielectric capacitor impregnants.

Complete performance data, ratings and sizes are in Engineering Bulletin 222, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Sprague on request will provide you with complete application engineering service for optimum results in the use of molded paper tubular capacitors.

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TELE-TECH
& Electronic Industries

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Realistic Pricing

Each year as the fall season starts we know that the buying tempo for home electronic instruments begins to accelerate. We know also that such acceleration brings with it intensified price competition. And we know too that when the latter becomes too keen it reflects industry instability ranging from the dealer back through the distributor, the equipment manufacturer, and ultimately to component parts suppliers. If one checks the ads appearing in newspapers now and notes the great price values that are being offered to the public, the tie-ins and the giveaways and reflects a little on past and current happenings it should be fairly obvious that unless all manufacturers price their wares realistically, there will be trouble in the months ahead.

The recent guaranteed annual wage afforded the workers in the automobile industry is bound to have complementary effects in other industries, and the basic raw material producers such as steel, aluminum, copper, etc. will undoubtedly be among the first to be affected. This of course will mean higher prices at the source that become compounded with successive processing services. The continued high level of government purchasing coupled with the new accentuation on space aircraft may well give rise to serious future material shortages. Finally, with engineering talent in such critical short supply, lack of employment stability can bring on a disaster for individual manufacturers. In short, we are in another price spiral and a realistic pricing program that is in step with changing times is mandatory!

Color-TV

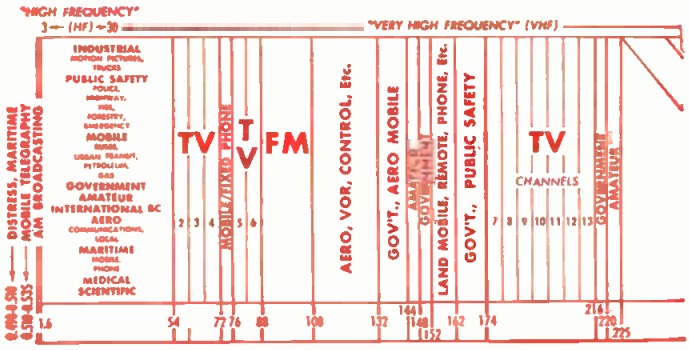
Also, with the fall season, color television programming increases five-fold over last year. A great many of these new shows are scheduled for network presentation. At the present time about 300 of 364 network stations in 241 cities are equipped to handle color. Only a handful of the 437 stations in the U.S. can originate their own color programs. As more receivers become available public interest in color television shows can be expected to increase markedly. Stations not now equipped for color might do well to reflect a little on new equipment requirements. If public interest rises rapidly and if a number of stations are then seeking equipment simultaneously, valuable revenues may be lost through delivery delays. Color-TV, incidentally, offers the broadcaster an opportunity through the ability to make a premium charge for color time.

Editorials

Recent editorials in Tele-Tech & Electronic Industries have evoked considerable industry interest. The IRE Committee on Electroacoustics and the IRE Committee on Recording and Reproductions has on its agenda to consider high fidelity standardization concepts. This stems from our editorial "High Fidelity at the Crossroads" appearing in the June issue. Letters are already coming in on last month's editorial entitled "On Conventions and Shows." On page 22 of this issue we present some of the letters we have received in the last month. We invite you too to express your views.

RADARSCOPE

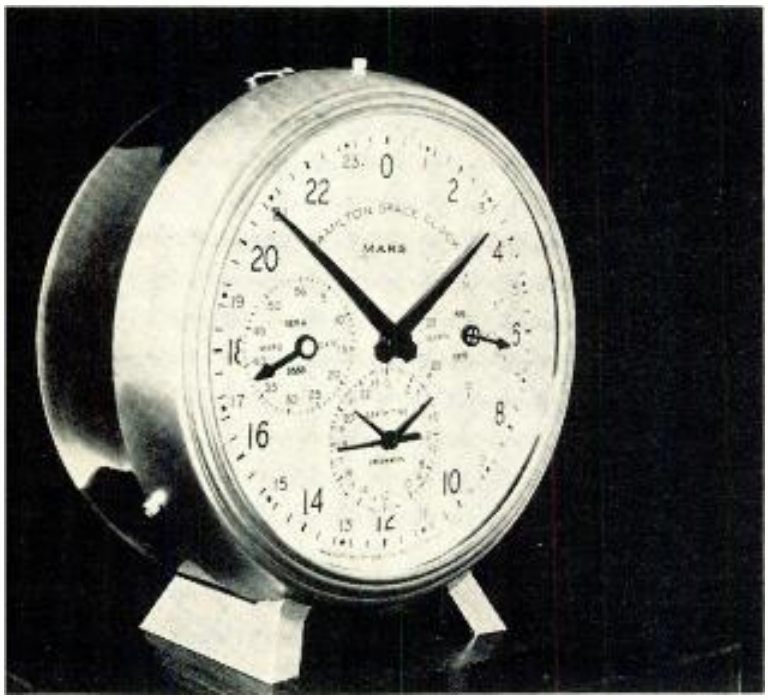
Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation



U. S. TARIFF COMMISSION has started a preliminary inquiry into a complaint filed by one of the nation's top transmitting tube manufacturers. The complaint charges injury resulting from imports of electron tubes and parts, and alleges patent infringements and unfair trade practices in connection with a number of transmitting tube types covered by U. S. patents. Invitations have been extended by the commission to all interested parties to file comments.

NEW COMPUTER CENTER, the nation's largest and most modern electronic testing and flight simulation laboratory for research on problems in aircraft design and guided missiles, will be built for the Air Research and Development Command, USAF at Wright Air Development Center, Wright Patterson AF Base, Dayton, O. by Reeves Instrument Corp., subsidiary of Dynamics Corp. of America. Construction begins immediately and will be completed within a year.

JETEC AND ASESA are seeking a new system of tube type coding for military equipment tubes. Present four number type designation fails to give any indication as to what kind of tube is involved.



"SPACE-CLOCK"

Conceived to demonstrate interplanetary time differentials which future space travel pilots must consider in their flight planning, this unique clock to be demonstrated by Hamilton Watch Co. at the 10th Annual Instruments and Automation Conference and Exhibit in Los Angeles, indicates simultaneously both Mars time and Earth time and calendar dates for both planets.

NEW SILICONE-MODIFIED enamel insulation for wires is said to make possible smaller electric motors with greater power. Tests conducted at Westinghouse Research Labs in Pittsburgh show that motors constructed with such wire can operate continuously for 10 yrs. at 325°F. without damage to the insulation.

RETMA STANDARDS PROPOSALS now being circulated for approval include: No. 439-Packaging Tests for Radio, Radio-Phono, High Fidelity Equipment and Recorders; No. 148 Addition to REC-113-C, Vibrators for Auto Radios—Vibrator Transformer Buffer Capacitance Determination; No. 446 Revision of ET-102B RETMA-NEMA Standards for Recommended Practice for Preparation of Outline Drawings of Electron Tubes and Bases.

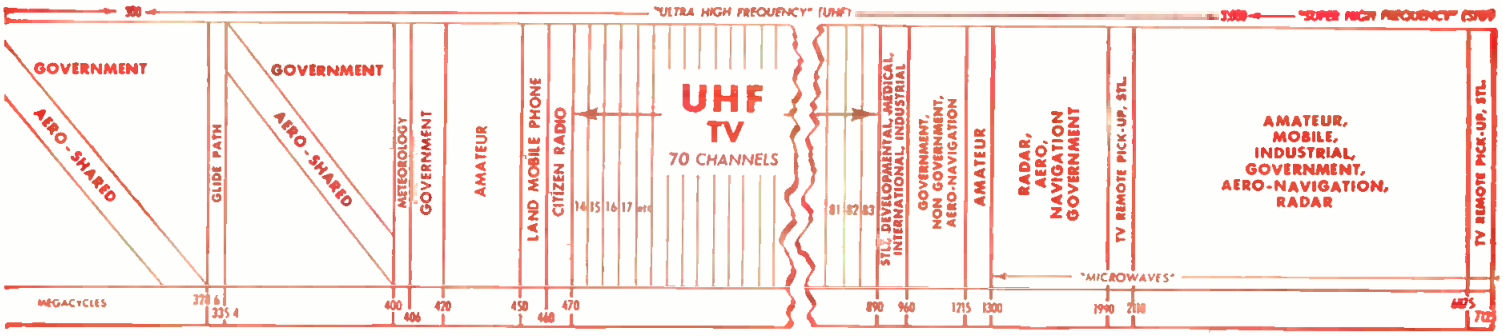
NEMA (National Electrical Manufacturers Association) is forming a Dry Battery Section. Representatives from nine manufacturers met in New York recently to organize the group.

EARTH SATELLITE to be launched during the International Geophysical year, which is a period set aside during 1957 and 1958 for world-wide observations in the fields of the earth sciences by some 40 nations. Such is the announcement emanating from the National Academy of Sciences and the National Science Foundation. The Department of Defense is to provide required equipment and facilities for launching. The instrument bearing satellite makes possible sustained observations in both space and time. It will orbit the earth for a period of days eventually disintegrating as it circles back into the upper atmosphere.

ELECTRONIC FUTURES

ELECTRONIC APPLICATIONS to retailing continue to grow. So reports Hilton & Riggio, Inc. of New York City citing the followings examples of recently announced devices:

1. A telephone recording device that takes orders when the store is closed.
2. An electronic device that takes simultaneous photographs of each check customers present for cashing and the person who presented it.
3. A machine to count and sort coupons issued by food manufacturers.
4. A musical-background directory lantern with space for product advertising for use in food stores.
5. A geiger counter to detect shop lifters. A minute amount of radio active material would be stamped on packages and detected near check-out counter.



MANPOWER

PLANT DISPERSAL among larger manufacturers brings with it added personnel problems. How to determine how many engineers with which specialties are currently employed? One manufacturer is now working on a program to completely detail the educational, experience and hobby interests of their engineers. Then through an IBM or similar system engineers with particular experience or background can be quickly located and formed into a special project group. Other manufacturers can be expected to follow suit.

RADIO ASTRONOMY

SCIENTISTS in Great Britain look forward to completion of the new giant radio telescope in Lower Withington, not far from Manchester. The parabolic reflector bowl is 250 ft. in diameter and contains 2000 tons of steel. It is expected to cost about $1.3 million upon completion. The telescope will detect "broadcasts" of great gas clouds and galaxies billions of light years away, far beyond the range of the great optical telescope perched atop Mt. Palomar in California. Another 250 ft. radio telescope is under construction in Sydney, Australia, aided by a $250,000 grant from the Carnegie Corporation of New York. American astronomers are considering plans to build two radio telescopes as big or bigger. One will be on the West Coast and the other somewhere East of the Mississippi.

FOREIGN TV

United Kingdom—Plans are being laid for regular color programming by 1958. Experimental color transmissions are slated to begin this Fall.

Italy—The 1956 government budget has set aside 84 billion lire for television expansion.

India—Television is expected to begin by early 1957, the first station to be located in Bombay.

Luxembourg—Tele-Luxembourg plans a power increase from 30 kw to 200 kw to extend the stations coverage to a French speaking audience of four million in Belgium, France, Luxembourg and The Saar.

Union of South Africa—Plans are being considered to construct a "floating" commercial TV station on a ship to be located 3 mi. off-shore. It would cover the four major ports, Durban, Capetown, Port Elizabeth and East London. Attractive features are the low installation cost—about $141,000—and minimum technical difficulties due to absence of mountains or other obstacles.

Estonia—The TV station at Tallinn began regular broadcasts on Aug. 6 using 625/25/8 MC/FM standards.

STRATOSPHERE FIELD STRENGTH

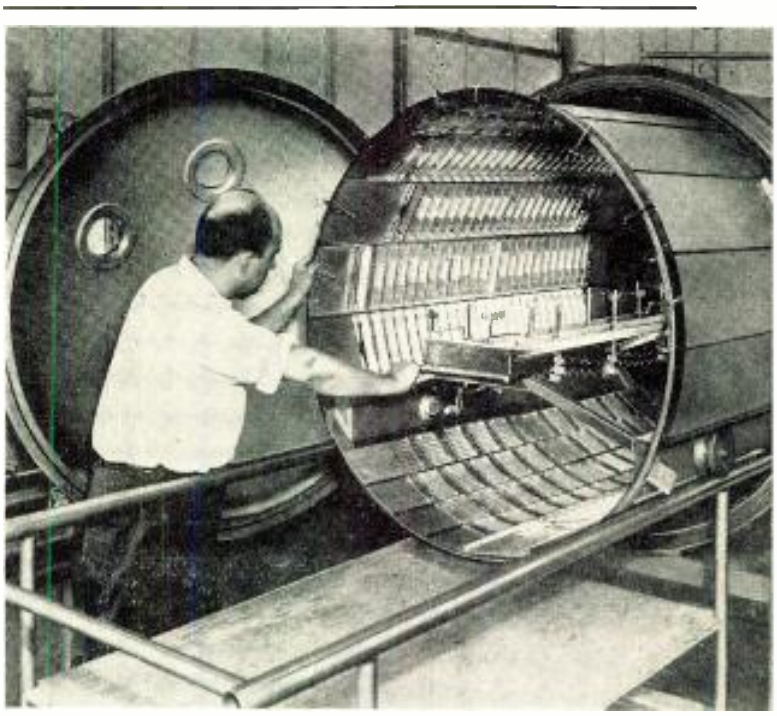
THE U. S. AIR FORCE is currently conducting a field strength measurement program through the 60,000 to 100,000 ft. altitude range. Data gathered is expected to assist materially in learning more about the nature of the electrical current constantly flowing toward the earth, a half-century mystery that scientists have been trying to fathom. At sea level the electric field may approximate 50 volts/ft. tapering off to about ½ volt/ft. at 100,000 ft. Tests from Orlando Air Force Base, Fla. will also measure electrical charges set up by thunderstorms. Special electronic field strength meters developed by Minneapolis-Honeywell with sensitivities $1/1000 \times 10^{-6}$ μamps are suspended about 500 ft. below huge plastic carrying baloons. Readings are telemetered back to the ground. Polonium collector rods, which ionize the surrounding air, increase electrical conductivity and thus accelerate measurements.

COMING SOON

November 1955—Annual Microwave Issue containing

- **Microwave Systems in United States**
- **Feature articles on latest microwave design techniques**

December 1955—Annual Printed Circuit Issue



SELENIUM RECTIFIERS

Several new Stokes vacuum metallizing units similar to the one shown have been installed at Westinghouse for making selenium rectifiers. Nickel-plated aluminum plates are placed in drum, and the drum rotated while the selenium and later the barrier are evaporated. Sheets are then cut into small rectifier plates.

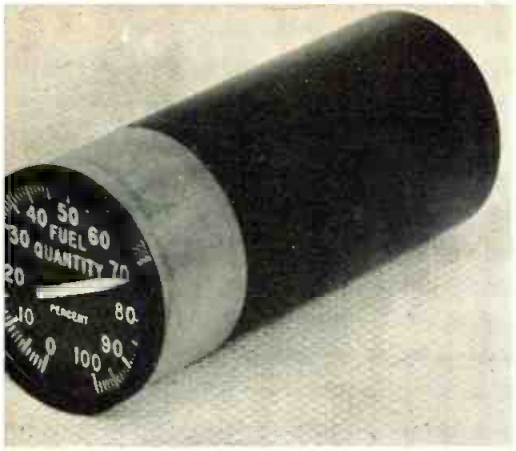


Fig. 1: Transistorized combination unit

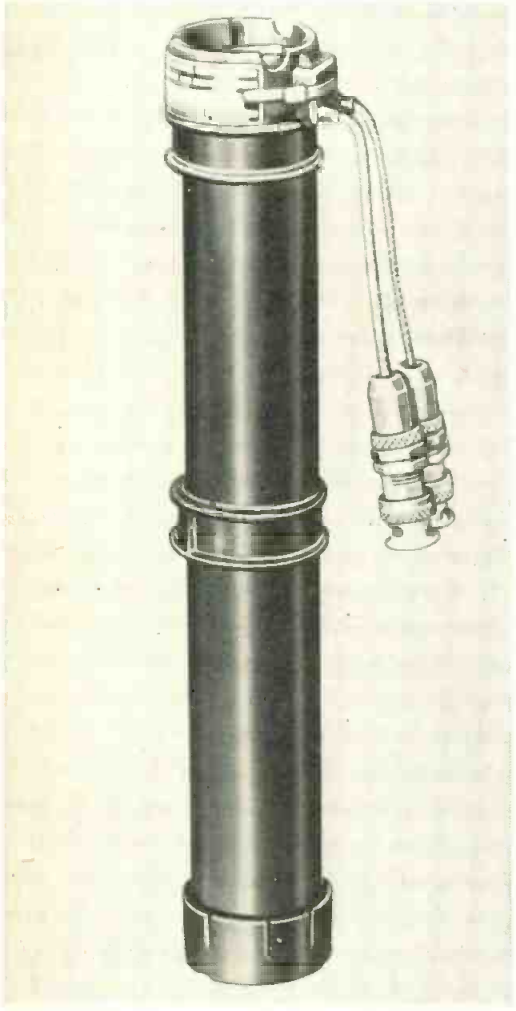


Fig. 2: Standard tank unit for mounting through wall tanks is completely inside of tanks except for electrical connections

Fig. 3: Flat skin mounting unit designed for application on thin-winged aircraft

Reliability of a properly designed capacitance fuel guage has been demonstrated over the past ten years. This reliability is materially increased through transistors to obtain necessary amplification between the sensing tank units and fuel indicator. The new combination system is described herewith.

By LEROY A. GRIFFITH

Aircraft Fuel Measurement

L. A. Griffith

■ The accurate and reliable measurement of fuel quantity is extremely important to the performance of aircraft because of the large quantities of fuel required for flight. If the pilot is to have adequate fuel for the return portion of the flight, he must carry extra fuel to the extent that his gage is unable to measure the fuel aboard. This excess fuel weighs approximately six to seven pounds per gallon, and amounts to large excess weights, especially in the larger airplanes carrying hundreds of thousands of pounds of fuel.

The reliability of a properly designed capacitance fuel gage has been demonstrated during the last ten years. This reliability is now materially increased through the use of transistors to obtain the necessary amplification between the sensing tank units and the fuel indicator.

The basic circuit functions of the three-wire Honeywell gage are not changed through the use of a transistor amplifier. The electrical arrangement of circuit constants to nullify the effects of moisture and conductive films is maintained. The ability to withstand the various mechanical environments associated with airplane flight is materially improved through the use of transistors.

Tank Unit

The tank units used for sensing the fuel quantity must be built from physically stable materials arranged in mechanical configurations to give maximum strength to the assembly and allow adequate flexibility in the tank installation. Cylindrical construction has proved to be the best and the most efficient shape.

The tank unit consists of an electro-static capacitor, the value of which is changed by the presence of fuel. This capacitance is varied in value along the length of the tank unit so that a constant capacitance per pound results from fuel placed in the fuel tank. These capacitances are located so as to compensate for pitch and roll of the fuel tank. The capacitance distribution or characterization of the tank unit effectiveness allows the transfer of fuel between tanks of unlike shape without affecting the accuracy of measurement. A grounded section alongside the sensing section of the tank unit capacitance materially improves the ability to design and manufacture tank units with close production control of magnitude and rate of change of the capacitance per inch.

A separate capacitance designed in the bottom of at least one of the tank units in the fuel tank system to be measured serves as a compensator for fuel and/or fuel temperature variation. This compensator is connected into the fuel gage circuit so as to compensate for changes in the electrical and physical properties of the fuel in such a manner as to give an accurate measurement of true mass. This compensation is accomplished by effectively sensing the change in di-electric constant of various fuels or combination of fuels in order to compensate for the differences in the electrical and physical properties. This compensating static capacitance has no moving

L. A. GRIFFITH is the director of transistor engineering at Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

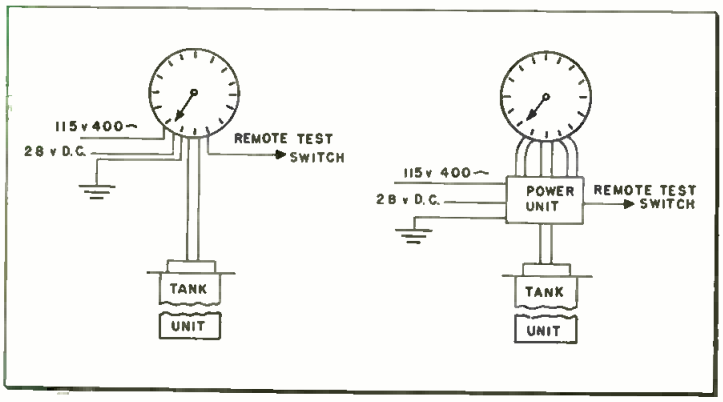


Fig. 4: (Left) Amplifier and power supply for old system
Fig. 6: Combination vs separate power unit system comparison

parts and is connected into the system with only one additional wire.

The installation of tank units in a fuel tank or combination of tanks to be gauged requires a careful analysis of fuel level versus pitch and roll. This information is used to distribute the capacitance along the tank unit length and the number and location of tank units in the tank in order to minimize the pitch and roll error. The mechanical mounting of tank units must take into consideration such factors as vibration, fuel sloshing, plus adequate strength and seals to prevent leaking. Standard tank units are available for mounting through tank walls, see Fig. 2, completely inside of the tanks except for external lead connections, see Fig. 3, and flat skin mounting for thin-winged aircraft.

Indicator

The tank unit capacitance is electrically balanced against a standard capacitance so as to give a signal proportional to fuel quantity. This small signal requires amplification before the power level is high enough to drive an indicator. The amplifier and system connections between the tank unit, indicator, and associated equipment are all built into the indicator. Since the power and control circuit lead connections have always represented a major portion of the design problem, a considerable simplification results from combining the amplifier, indicator, and system connection functions.

The use of transistors and miniaturization makes possible the re-

(*Continued on page* 113)

Table 1: Accuracy of Minneapolis-Honeywell Compensated Fuel Gauge System

Maximum Indicator Error Due To:	System Error Due To Manufacturing Tolerance					
	At The Empty Point		At Half-Full Point		At The Full Point	
	Maximum	Probable	Maximum	Probable	Maximum	Probable
1. T. U. Empty Capacitance (±0.5%)	0	0	±0.25%	±0.10%	±0.50%	±0.20%
2. Compensator Empty Capacitance (±1.5%)	0	0	±0.34%	±0.16%	±0.68%	±0.32%
3. System Deadspot (±0.2%)	±0.20%	±0.15%	±0.20%	±0.20%	±0.20%	±0.15%
4. Dial Graduation Tolerance (±0.1%)	±0.10%	±0.07%	±0.20%	±0.07%	±0.30%	±0.07%
*5. Reference Capacitance (±1.0%)	0	0	0	0	0	0
6. Indicator Scale Linearity (±0.5%)	0	0	±0.50%	±0.40%	0	0
7. T. U. Characterization Tolerance (±1.5%)	0	0	±1.50%	±0.25%	0	0
**8. Voltage Variation (±0.0%)	0	0	0	0	0	0
**9. Frequency Variation (±0.0%)	0	0	0	0	0	0
*** SUMMARY						
Effective Over-All Error		±0.17%		±0.53%		±0.41%
Allowable Sum by MIL-G-7818	±1.00%		±2.00%		±3.00%	

* Reference Capacitor Tolerance cancelled out in calibration adjustment
** The maximum error allowed by Spec. MIL-G-7818 for voltage and frequency variations is ±0.5%
*** Effective over-all error is the square root of the sum of the squares of the individual errors.

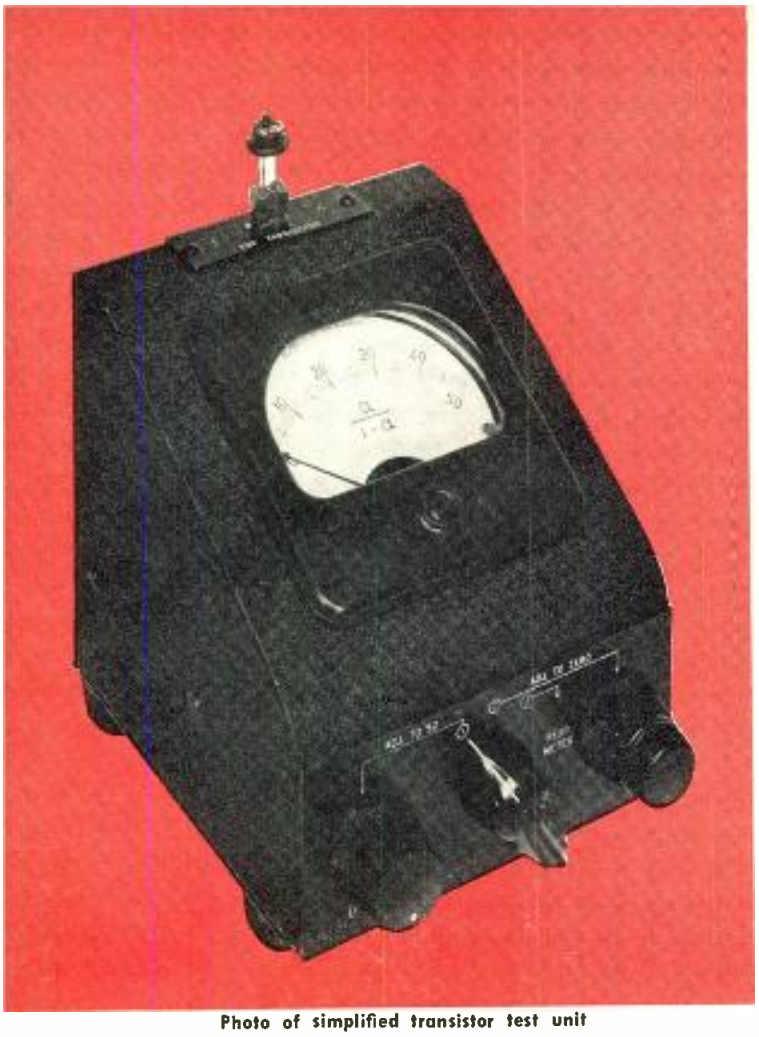


Photo of simplified transistor test unit

Circuit design details for new instrument developed to measure short circuit current-amplification factors

By A. D. BENTLEY
S. K. GHANDI
V. P. MATHIS

Simplified

OF the various parameters that may be used to define the low frequency properties of the junction transistor, it is perhaps safe to say that the short circuit current amplification factor is the most significant. The reason for the significance of this parameter may be seen with reference to Fig. 1.

Consider an iterative stage in a transistor amplifier. Then the power gain is given by[1]

$$G = \frac{i_2^2 R_L}{i_1^2 R_{IN}} = \frac{i_2^2 R_L}{i_1^2 R_L} = \left(\frac{i_2}{i_1}\right)^2$$

Since the transistor iterative stage usually works into an impedance approaching short circuit conditions, the power gain of the stage is therefore given approximately by the square of the short circuit current amplification.

The grounded emitter configuration is commonly used in iterative stages. The small signal measurement of its short circuit current amplification is usually made in the following manner:

1. Establish a suitable dc operating point.
2. Short circuit the output to ac.
3. Feed in a known small signal audio frequency current at the input terminals (1000 or 270 cps is commonly used).
4. Read the ac current in the output circuit by observing the ac voltage across a small resistor in series with the output.

A study of this procedure shows that it is necessary to have a minimum of two metered bias supplies, a signal generator and a vacuum tube voltmeter; an oscilloscope is a desirable accessory to monitor the waveforms, and the problem of hum pick up must be overcome. A closer inspection of the basic principle of measurement will show that it is possible to simplify the measurement considerably without undue sacrifice of accuracy.

Consider the static characteristic of Fig. 2, with a dc operating point at P (I_{co} I_{bo}). Assuming that we have a peak reading meter, and that the input signal is small enough so that Q'PQ is a straight line, the input signal causes the operating point to move around P by an amount $\pm \Delta I_{bo}$. The output current moves $\pm \Delta I_{co}$, and the ratio of these two perturbations is the parameter we wish to measure. It is easy to see that we would get the same reading if our input wave-form was a square wave of amplitude $\pm \Delta I_{bo}$. In fact, the only reasons for generally using sinusoids are the ease of generation, and the ease of measurement. Since the characteristic is linear around the point P, we may go one step further and use either a positive, or a negative wave rather than an alternating waveform. The maximum simplification finally occurs when a step waveform is used for the input signal, as in either Fig. 3A or 3B.

As long as the step height is small

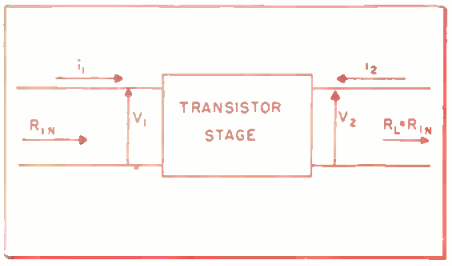
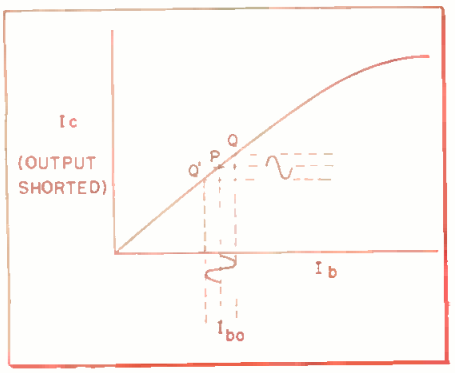


Fig. 1: Considerations in determining short circuit current amplification factor

Fig. 2: Transistor static characteristics



A. D. BENTLEY, S. K. GHANDI and V. P. MATHIS are in the Electronic Laboratory, General Electric Co., Syracuse, N. Y.

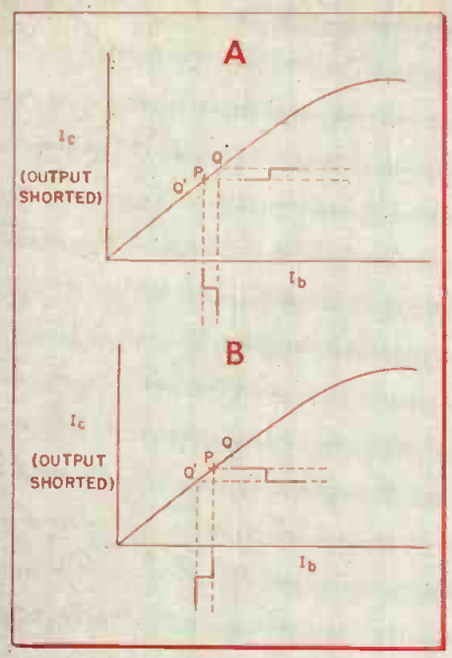


Fig. 3: Maximum simplification finally occurs when step waveform is used for input signal as illustrated in (A) and (B) above

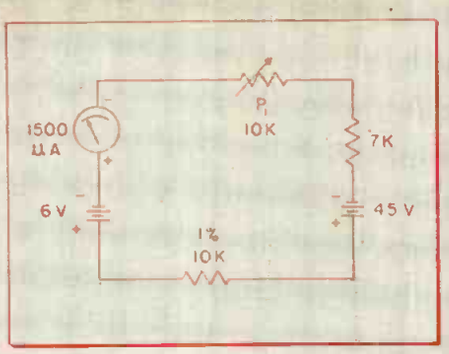


Fig. 4: (Above) Adjusting P_1 till meter reads full scale for 1.5 ma constant current

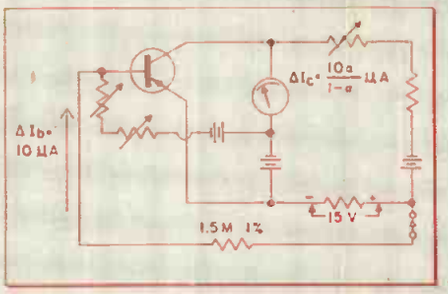


Fig. 5: Zeroing meter via P_{2a} and P_{2b}

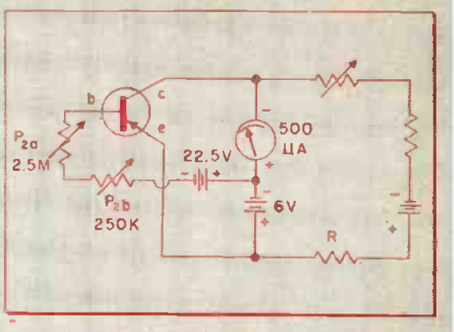


Fig. 6: (Above) Reducing base current by application of 15v to base emitter circuit

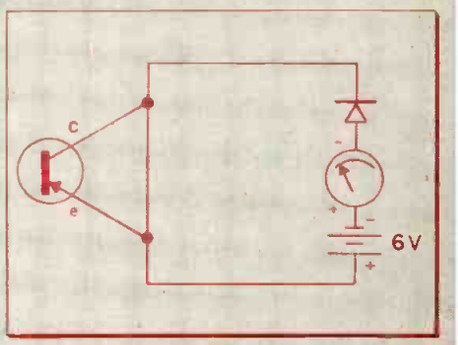


Fig. 7: Circuit for emitter-collector shorted

Transistor Test Equipment

enough so that QPQ′ is a straight line, this method is certainly as accurate as the small signal ac method. Also, since no ac is involved, the problem of pick up is eliminated, and a simple dc meter may be used.

The design of such a piece of equipment was undertaken to see if this technique would result in a simple instrument. To simplify the problem, the instrument was designed for the following limited application:

1. Measures p-n-p transistors only.
2. Measures at an operating point* of 6 v V_c and 1.5 ma I_e. (This is close to the standard operating point of V_c=5 v, I_e=1 ma. Since α is relatively independent of V_c and I_e, the values of current amplification measured at the two points usually agree within 5%.)
3. Measures α from 0-50.
4. Battery operated, self-contained, single meter operation.

Measurement Scheme

The following procedure was chosen:

1. Adjust a constant current source to deliver 1.5 ma (include a 10K resistor in this circuit to give a standard voltage of 15 v).
2. Apply 6 v to the transistor and adjust its collector current to exactly 1.5 ma by bucking out the standard current obtained in step 1.
3. Reduce the base current by exactly 10μA, making use of the standard 15 v source of step 1.
4. The meter reads the change in collector current.

The circuit may now be derived as follows:

1. Obtain a constant current source of 1.5 ma, as in Fig. 4, by adjusting P_1 till the meter reads full scale.
2. Set the transistor at 6v V_c and 1.5 ma I_c, by adjusting P_{2a} and P_{2b} until the meter reads zero. (See Fig. 5.) The meter is switched to a more sensitive scale of 500μA, and is now in the arm of a balanced bridge circuit. At this point, the transistor is biased to 1.5 ma I_c, and 6 v V_c. The voltage across R is exactly 15 v.
3. Reduce the base current by 10 μA by applying the 15 v. developed across R, to the base-emitter circuit through a 1.5 megohm resistor, as in Fig. 6. (At this point the collector current falls by 10 μA).
4. The change of current in the base shows up as a change in the collector. This unbalances the bridge, and the meter reads this unbalance. The unbalance current is

$$\frac{10\alpha}{1-\alpha}$$

μ amps. Since the meter is 500 μA full scale, this may be calibrated directly for values of

$$\frac{\alpha}{1-\alpha}$$

from 0-50.

A few general comments must be made at this point:

1. A 45-v battery in the constant current source allows 26K ohms as the resistance of this supply. This resistance must be large so that ΔI_c flows through the meter path when I_b is reduced.
2. The base current is adjusted by P_{2a} and P_{2b}. P_{2b} functions as a vernier adjustment. It is important that the meter be zeroed precisely.

This method of biasing the transistor will only hold if $I_{co} < I_e (1-\alpha)$. For $I_e \approx$ 1.5ma, and

$$\frac{\alpha}{1-\alpha}$$

ranging from 0-50, this restricts the I_{co} to values under 30 μA. Since the usual ratings for transistors at this operating point specify an I_{co} of under 10 μA, this condition is easily met.

An extra 22.5-v bias battery is placed in series with the base lead to keep the external base to emitter

(*Continued on page* 118)

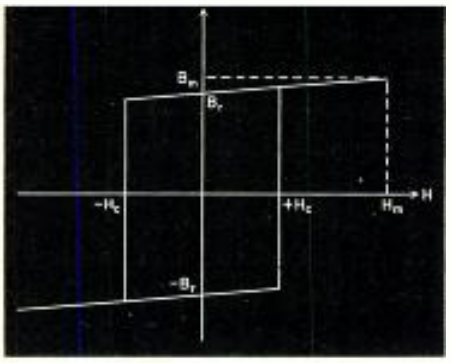


Fig. 1: Idealized d-c hysteresis loop

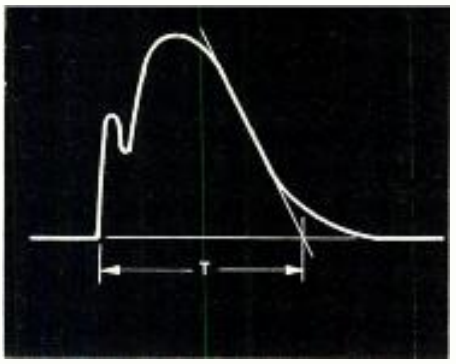


Fig. 2: Switching time definition

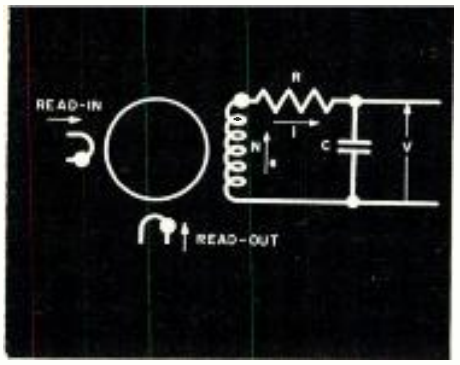


Fig. 3: Circuit for flux and squareness

Ferromagnetic Computer Cores

Importance of rectangular-hysteresis-loop cores in discrete-data processing systems makes continual study of characteristics necessary. Of primary importance are: d-c coercive force; squareness ratio; flux change; switching time. Switching improvement in ⅛ mil 4-79 Permalloy core detailed.

By CHARLES F. DEVENNY Jr. and LYLE G. THOMPSON

THE magnetic properties of the ferromagnetic core have in the past few years been developed to maximize specific characteristics of particular value in computer applications. The ability of these cores to store binary information reliably and the ease of transferring information from one core to another in a few micoseconds make the core a very versatile component in discrete-data processing systems.

C. F. Devenny

L. G. Thompson

The rectangular-hysteresis-loop ferromagnetic core characteristics to be described in this paper pertain to the 4-79 Permalloy and 48% Ni-Fe alloy metal tape cores. These cores consist of a number of wraps of ⅛ to 1-mil thick metal tape wound on a ceramic bobbin. The last wrap is usually spot welded in place and then the entire assembly is annealed in a dry hydrogen atmosphere to achieve the desired magnetic properties.

At Burroughs Research Center considerable effort has been expended in the application of magnetic cores or BIMAG elements to all sections of complex data processing systems. The extensive work in this field has required close coordination with the manufacturers of magnetic cores.

A previous paper by Wylen[1] covers the earlier phases of the Burroughs BIMAG core development program and gives detailed information on the actual pulse waveforms of various types of magnetic cores.

This article describes more recent developments from the viewpoint of tolerance limits that can be expected for the four characteristics of primary importance. These characteristics are (1) d-c coercive force, (2) squareness, (3) flux change, and (4) switching time. The tremendous improvements in swtching time that have been achieved by intensive effort on the ⅛-mil 4-79 Permalloy type of BIMAG core are also presented.

Magnetic Core Characteristics

Fig. 1 shows an idealized rectangular d-c hysteresis loop which will serve to illustrate the bistable nature of the magnetic core. Two of the four important characteristics to be considered are also indicated in Fig. 1. The first of these is that the residual magnetization (B_r) is very nearly equal to the maximum magnetization (B_m). The ratio of B_r to B_m is commonly referred to as the squareness ratio. The second characteristic indicated in Fig. 1 is the d-c coercive force (H_c). The d-c coercive force of the magnetic tape materials used in computer circuits is a small fraction of the d-c coercive force of the more usual transformer type magnetic material.

The two remaining characteristics of primary importance are the switching time and the flux change. The switching time is the time required to change the magnetic core from one state of residual magnetization to the opposite state of maximum magnetization. The flux change is the amount of flux that is changed during this transition. Fig. 2 shows a typical waveform of the voltage induced in a one turn output winding on an "unloaded" magnetic core during the switching time. The switching time, T, has been defined as the intersection, with the time axis, of an imaginary straight line drawn tangent to the predominant falling edge of the waveform. This definition of switching time was adopted because it represents the minimum duration of the pulse magnetizing force that must be applied in order to insure minimum complete switching.

Fig. 3 shows an integrator circuit

C. F. DEVENNY and L. G. THOMPSON are engineers at the Burroughs Corp. Research Center in Paoli, Pa.

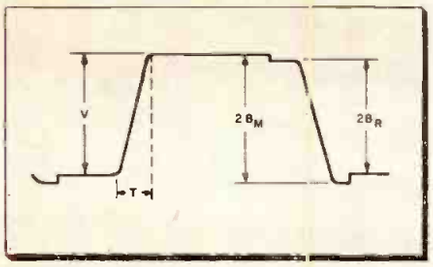


Fig. 4: (Above) Typical oscilloscope waveform

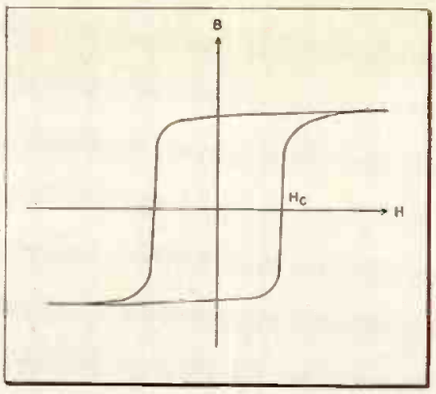


Fig. 5: (Center) Typical d-c hysteresis loop

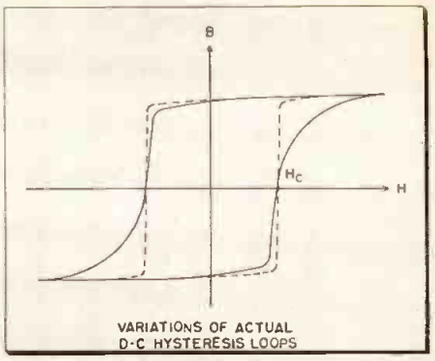
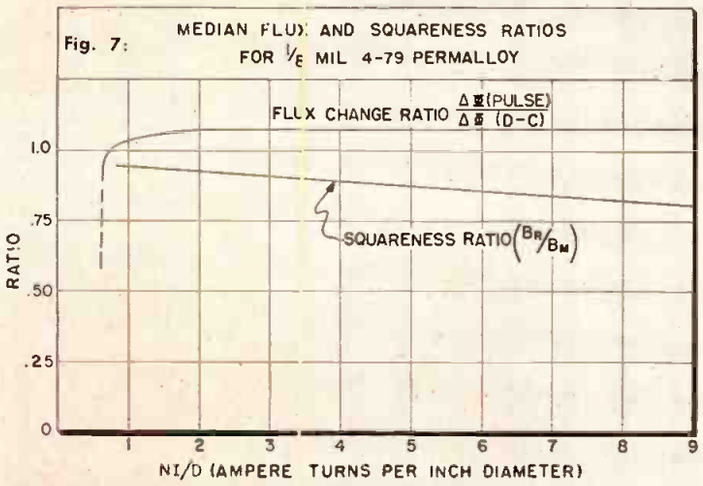
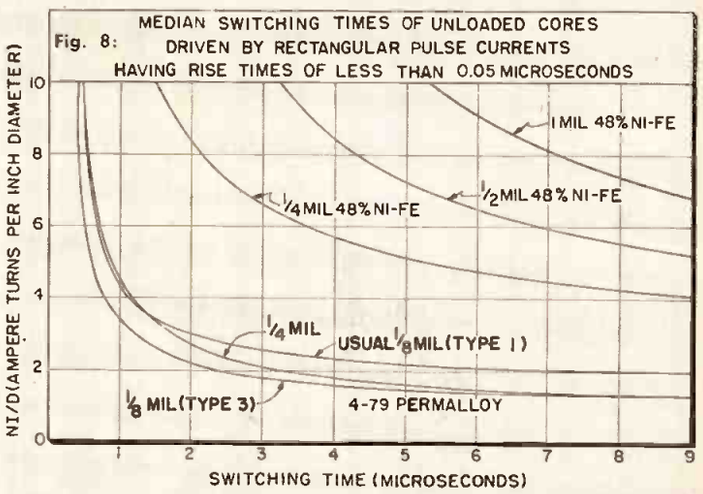


Fig. 6: Variations of actual d-c hysteresis loops





used to measure the flux change during the switching time of a core. The value of flux change may be obtained from

$$\Delta\phi = \frac{RC}{N} V \qquad (1)$$

provided the RC time constant is much longer than the switching time. If the RC time constant is expressed in seconds, V in volts, and N is the number of turns, Eq. 1 gives the flux change in webers.

Fig. 4 shows a typical waveform for the voltage appearing across the capacitor of Fig. 3 when the magnetic core is repetitively switched from one state of magnetization to the other by rectangular current pulses applied alternately to the read-in and read-out windings. The voltage, V, indicated in Fig. 4 is the voltage used in Eq. 1 to determine the total flux change during the switching time, T.

Fig. 4 also provides a basis for measuring squareness ratio. Since the vertical extremes of the waveform are indicative of the maximum magnetizations (2 B_m) and the plateaus are indicative of the residual magnetization conditions (2 B_r), the squareness ratio B_r/B_m can be measured directly from the waveform appearing across the capacitor of Fig. 3.

In brief, then, the four important characteristics to be described in detail are (1) d-c coercive force, (2) squareness ratio, (3) flux change, and (4) switching time. The last three characteristics are functions of the applied magnetizing force.

The magnetic cores of primary interest are all fabricated in the form of toroids. Thus, it becomes convenient to use the ampere turn/in. diameter as a unit for expressing the pulse magnetizing force. This eliminates the use of Pi in computations and, more important, provides a normalized basis for comparison of magnetic cores having different diameters.

A wide range of useful magnetic core characteristics are available to the electronic engineer at the present time. The rectangular-hysteresis loop magnetic core materials most commonly employed in computer type applications are the 4-79 Permally and 48% Ni-Fe alloy. These basic materials are available in a variety of tape thicknesses. Only the 1/8-mil and 1/4-mil 4-79 Permalloy and 1-mil, 1/2-mil and 1/4-mil 48% Ni-Fe alloy tapes will be discussed.

Fig. 5 shows a typical d-c hysteresis loop for all of these magnetic tapes. No values are shown for B or H_c since the various types of magnetic tape material plus variations in the annealing cycle allow a choice of nominal values for flux density and pulse magnetizing force to achieve a given switching time.

D-C Coercive Force

The d-c coercive force, H_c shown in Fig. 5, is primarily determined by the magnetic material and the thickness to which the material is rolled. Variations in the annealing cycle can, however, cause a two to one variation in the d-c coercive force for a given magnetic core configuration. Data taken on 48% Ni-Fe alloy and 4-79 Permalloy cores indicate that the usually published coercive force values are only approximate. Variation of ± 50% may be expected unless closer tolerances are specified.

Variations in Hysteresis Loop

Fig. 6 shows the variations that can occur in the shape of actual d-c hysteresis loops. These variations have been observed for all the tape materials under discussion. The dashed curve indicates the degree to which the idealized d-c hysteresis

(*Continued on page 84*)

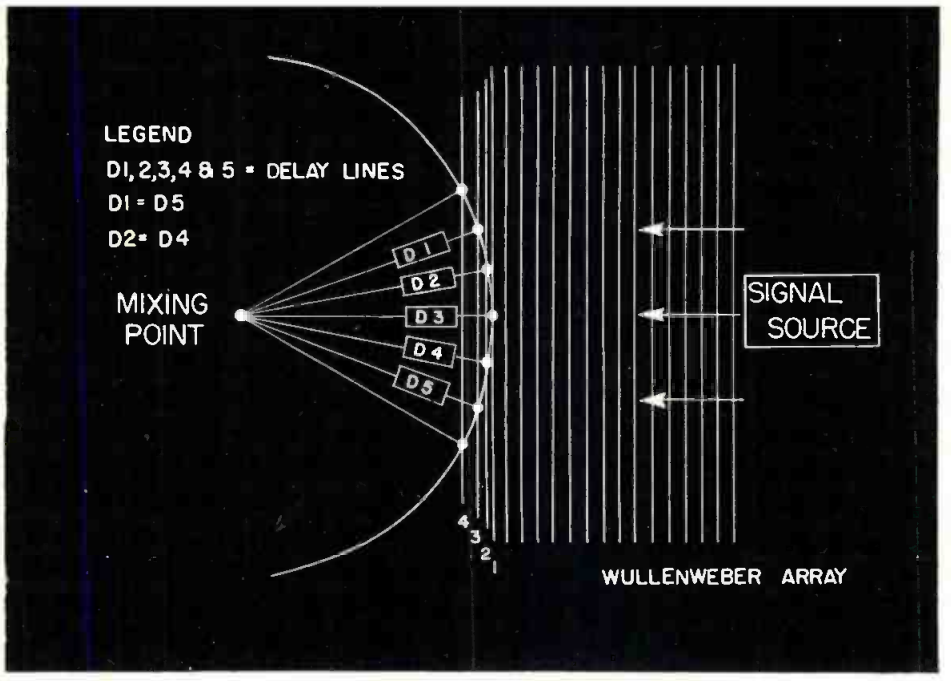


Fig. 1: Principle of operation of the Wullenweber type antenna

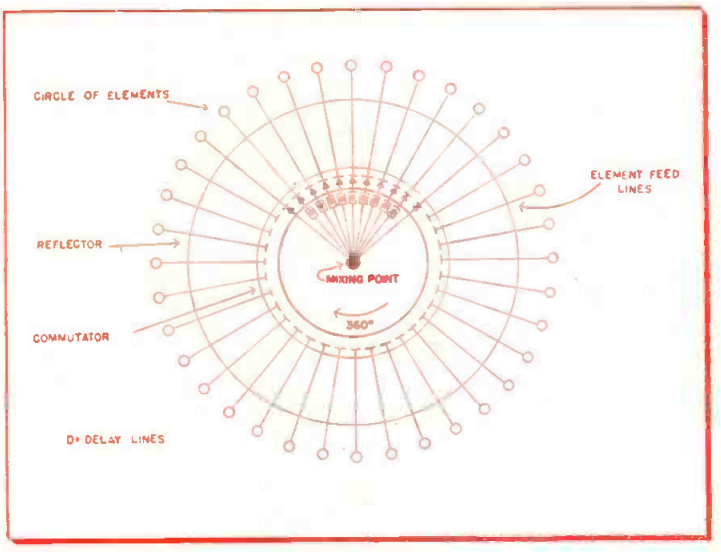
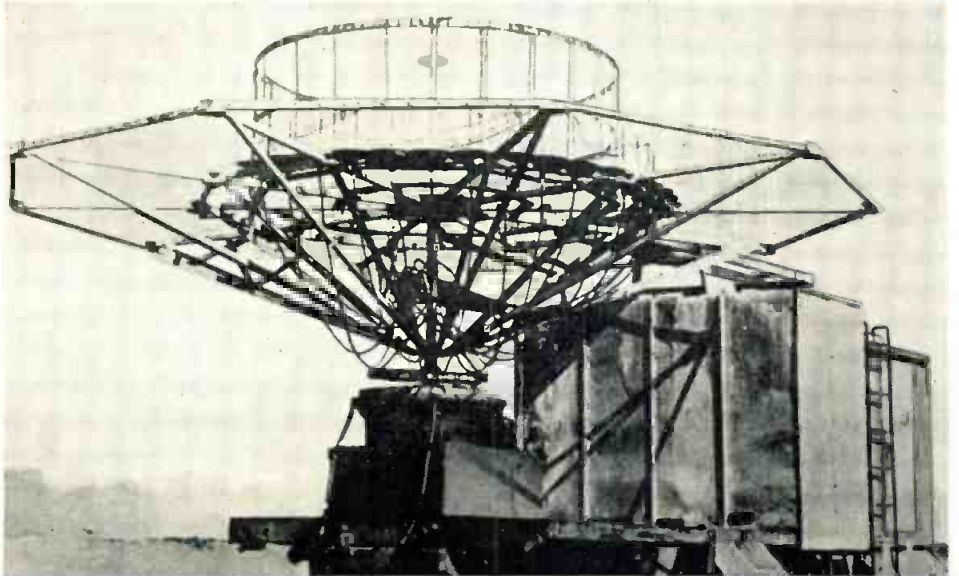


Fig. 2: Signal is picked up from elements by commutator action

Fig. 3: Experimental model bore out theoretical data



Design for

By R. C. BENOIT, Jr.
and M. W. FURLOW

THE Wullenweber type ultra high frequency radio direction finder developed under USAF sponsorship, and nomenclature "The Radio Direction Finder AN/GRD-9," is the outgrowth of considerable engineering effort expended over the past decade and a half by various scientific groups in this country and abroad.

During W.W. II, German scientific effort in the field of radio direction finding was directed toward the development of wide aperture high frequency shore based direction finding systems employing highly directional beam antennas. The Wullenweber technique was conceived and exploited under the direction of the German Naval Ministry as the most promising approach in an effort to obtain improved performance over the then universally used Adcock systems.

Operation

The technique was reduced to practice by the Germans and as a result, two high frequency Wullenweber direction finders were constructed and evaluated. The evaluation results clearly indicated the operational advantages of a wide aperture Wullenweber over other known techniques in the high frequency spectrum.

The technique is essentially a method whereby the equivalent pattern of a mechanically rotating planar array of antennas is obtained by means of a number of fixed antenna elements symmetrically disposed in a circle, behind which, is placed a circle of symmetrically disposed discrete reflectors or a continuous circular reflector.

In order to convert this configuration to the equivalent of a rotating planar array, it is necessary to select a sector of adjacent elements and, in effect, progressively rotate

R. C. BENOIT, JR., Rome Air Development Center, Rome, N. Y. and M. W. FURLOW, Melpar, Inc., 452 Swann St., Alexandria, Va.

Wide-Aperture Direction Finders

Wullenweber type UHF radio DF duplicates pattern achieved by rotating planar arrays by utilizing fixed antenna elements symmetrically disposed around circle

the sector around the array by some means of commutation. In addition, it is necessary to properly delay the signals from the various antenna elements selected so that the signals will arrive at a common mixing point in phase and thus be additive.

Fig. 1 illustrates the principle involved. It shows a group of seven adjacent antenna elements placed on an arc of a circle and a signal source at a sufficient distance so that the wave front arriving at the elements can be considered planar.

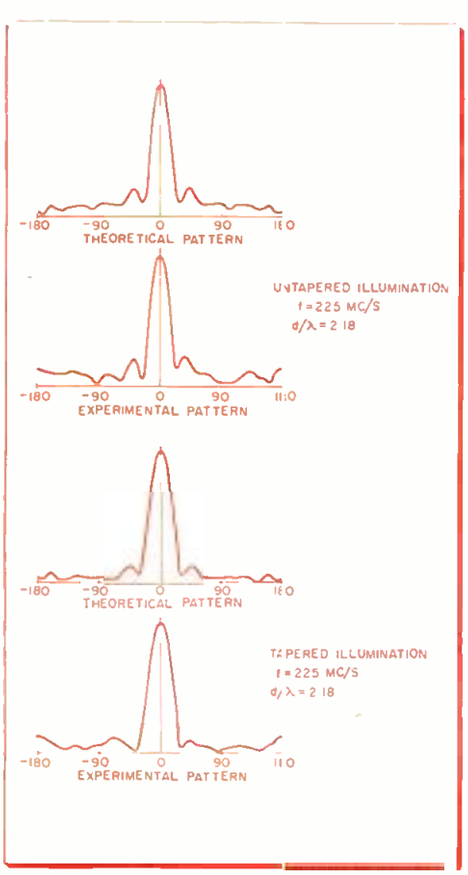
As can be seen, the wave front arrives first at the elements shown in Plane 1 and at time intervals later at the elements in Planes 2, 3 and 4. Therefore, to achieve the desired planar antenna pattern, it is necessary to delay the signal arriving at the elements in Planes 1, 2 and 3 by the amount of time required for the wave front to travel in free space from these planes to Plane 4 wherein the outermost elements of the sector are found. Side lobe attenuation is accomplished by tapered illumination of the sector of elements. This is essentially the introduction of discrete amounts of attenuation in various elements of the sector.

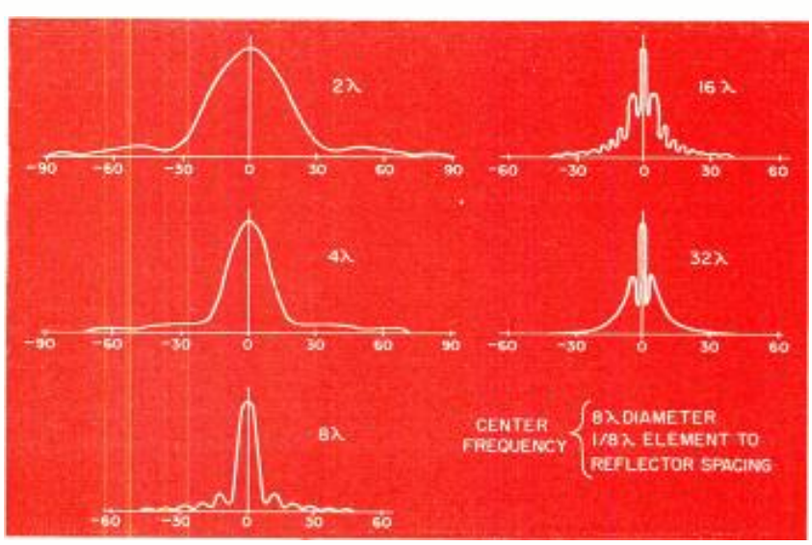
Fig. 2 shows the evolution of the principle to achieve 360° azimuthal coverage. All the array elements are connected to a switching device or

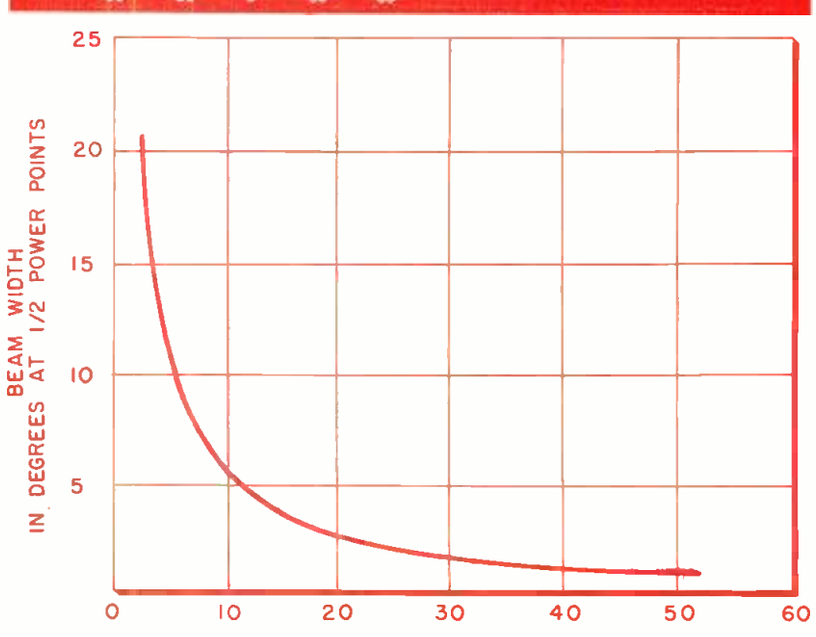
Fig. 4: (below) Experimental vs. theoretical patterns; tapered and untapered illuminations

Fig. 5: (r) Theoretical horizontal patterns

Fig. 6: (right below) Theoretical beam width vs. array diameter for Wullenweber array







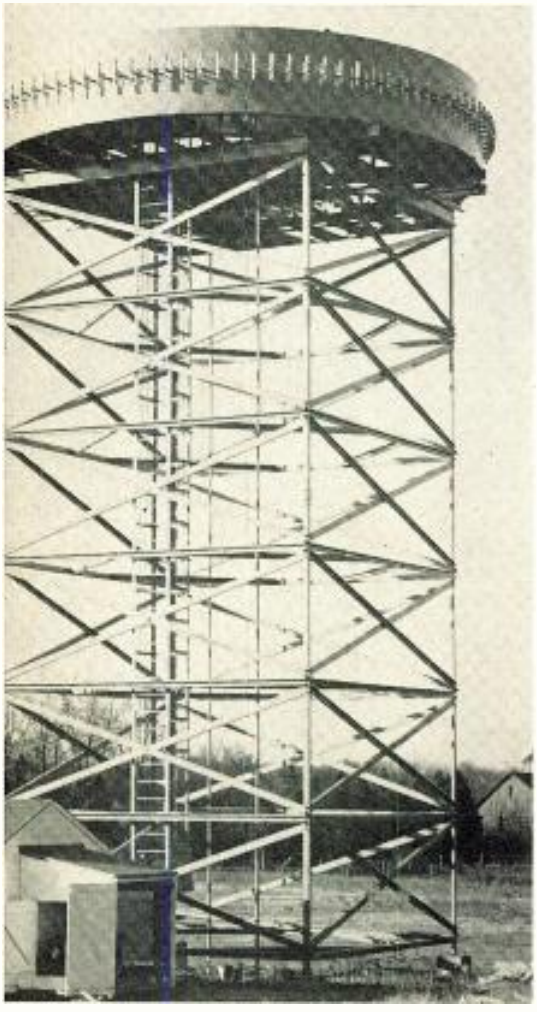
Direction Finder (continued)

commutator containing the necessary delay lines, which is located at the center of the array. The rotor selects a predetermined number of adjacent antenna elements and when rotated progressively, advances the sector of active elements around the array, thus causing the pattern to advance progressively in azimuth.

Advantages

A wide aperture direction finding system employing the Wullenweber technique has decided advantages over narrow aperture systems such as the Adcock. These advantages are in terms of sensitivity, azimuth accuracy under other than ideal conditions, wide band performance and the ability to simultaneously resolve the bearings of several signals on the same frequency, providing they are separated in azimuth by more than the beam width of the antenna and its minor lobes; hence, the term "Multi-Signal Direction Finder." Greater sensitivity is obtained as a result of the antenna gain. Accuracy is improved by minimizing the problem of site errors. The reason this occurs is very readily apparent because siting conditions do not change the direction of the wave but distort the wave front and if this distortion is small in comparison to the aperture of the antenna, it will have little effect on the bearing accuracy. The disadvantages of such a system are its physical aspects, especially at the lower frequencies and the economic considerations.

Fig. 7: Experimental Wullenweber array



USAF Research

In the years immediately following W.W. II, the Air Force became interested in the Wullenweber principle for possible application to radio direction finding in the frequency range of 225—400 MC. Preliminary studies were initiated at the USAF Watson Laboratories to determine the advisability of pursuing the Wullenweber approach for operation in the UHF range. These studies indicated that in terms of performance, this technique offered much promise.

Following the initial Air Force study, a research study contract was awarded Syracuse Univ. by the Air Force to completely study the problem theoretically and verify theoretical data and conclusions by experimental measurements. During the course of this work, experimental models were fabricated and evaluated against theoretical data. Fig. 3 shows one of the models. Experimental data obtained from the arrays indicated excellent correlation with theoretical data computed at the Harvard Univ. Computer Lab.

Fig. 4A illustrates a typical experimental vs. a theoretical pattern with untapered array illumination. Fig. 4B shows the same array with tapered illumination. The side lobe attenuation is worthy of note.

From an analysis of the Havard patterns, it is believed that frequency coverage on the order of 10 : 1 or better, can be achieved with a single Wullenweber array. Fig. 5 shows theoretical horizontal patterns over a 16 : 1 frequency range for a basic array having ⅛ λ element to reflector spacing and 8 λ diameter at the center frequency. The patterns were computed assuming continuous current distribution and infinite reflector height. The theoretical beam width vs. the array diameter for a Wullenweber array is shown in Fig. 6.

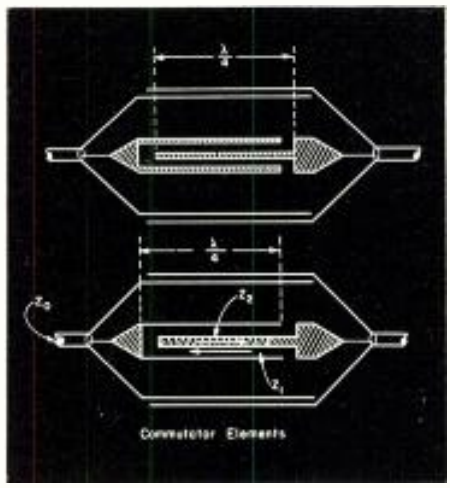


Fig. 8: Construction of commutating elements

The Syracuse Univ. effort further indicated that optimum performance could be expected when the element spacing was limited to ½ λ or less and the element to reflector spacing was limited to ¼ λ or less. At UHF a ground plane was found unnecesary, providing the array is placed several wavelengths above ground.

USAF Requirements

When the Air Force decided to have a developmental Wullenweber built, the specifications were detailed only to the extent that would insure the desired operational characteristics. These characteristics were: An antenna beam width about 6°, rotating at least 600 rpm and covering the frequency range of 225 to 400 MC, with the output displayed on a CRT indicator. During development it became apparent that the system readily breaks down into four major parts: the stationary antenna array, the r-f switching circuit which provides the beam rotation, the receiver and the indicator. The first two parts taken together really constitute the Wullenweber array, and their development consumed the major portion of the effort.

The Approach

The results of previous studies had indicated that an array 10 meters in diameter would give a 6° beamwidth at a design center frequency of 340 MC and that the spacing between the elements of the circular array should be no more than half wave at the highest frequency. A total of 100 elements was, therefore, required, giving half wave spacing at 400 MC. Of this number, the design called for 36 to be active

(*Continued on page* 104)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Gates Proof of Performance Simplified

HOWARD SHEETS,
Chief Engineer
Radio Station WNOR
Norfolk 7, Va.

RADIO Station WNOR, Norfolk, Va., is a Gates equipped station throughout using the MO-2639 modulation monitor and the SA-131 Proof of Performance equipment.

Installing the r-f rectifier pickup coil in the Gates BC-250-G transmitter was always something of a chore so the circuit of the MO-2639 modulation monitor was examined to see if it could also serve as the r-f rectifier for the distortion meter. Since the r-f pickup coil of the modulation monitor is permanently installed in the transmitter, it was decided that the addition of a small 1.0 mfd., 600 v. transmitting-type capacitor to serve as a coupling to the output of the 6x5 r-f rectifier of the modulation monitor was all that was needed. This capacitor was mounted under the chassis. A lead was run from the junction of R_1 and R_{27} (See schematic of MO-2639) to one terminal, and a lead was run from the other terminal to the terminal strip at the rear of the modulation monitor. This lead was connected to terminal (9) which is not normally used. Terminal (10) is connected to the chassis (ground), providing a convenient ground terminal for a single-conductor shielded-lead between the output of the modulation monitor r-f rectifier and the input of the distortion meter.

$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rates will be paid for material used.

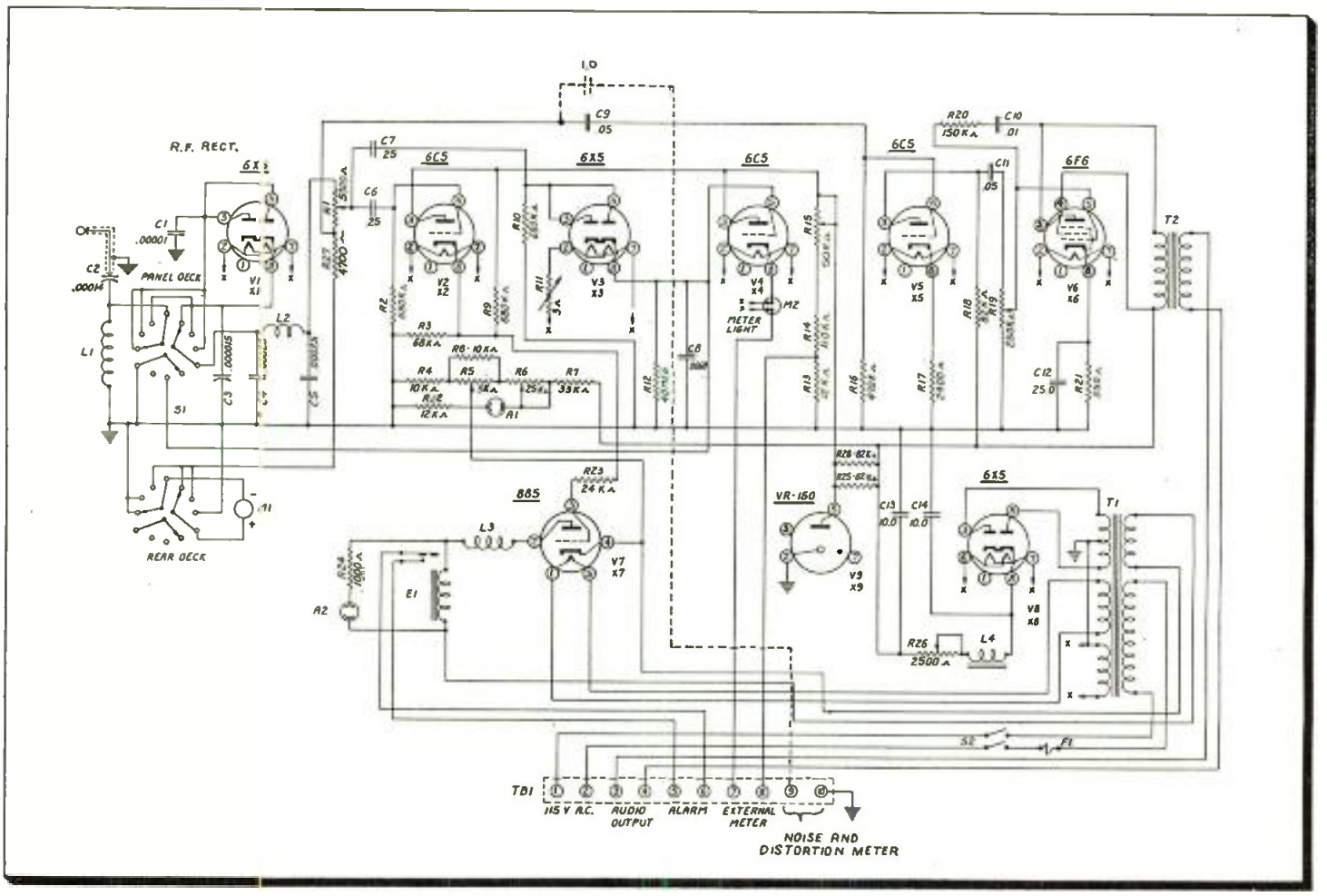
This method of providing audio for the distortion meter has proved entirely satisfactory, and it's a great time and temper saver in the wee hours of the morning.

Rack Light

DALE GORSUCH
Radio Station KWBC,
Fort Worth 2, Texas

WHEN working on a rack, instead of working in the dark or taking trouble to get out a long extension light, try this: Obtain an ordinary lamp socket. If possible one with about 3-in leads attached. Connect these leads to an ordinary wall plug. The next time you wish to do some work on a rack, plug this short extension lam pinto one of the ac outlets in the rack. This will let you obtain light in the rack in a quick, easy manner, and there are no long wires to clutter up the floor.

1.0 µfd., 600 v. capacitor added to ckt as shown serves as coupling to output of the r-f rectifier of the modulation monitor



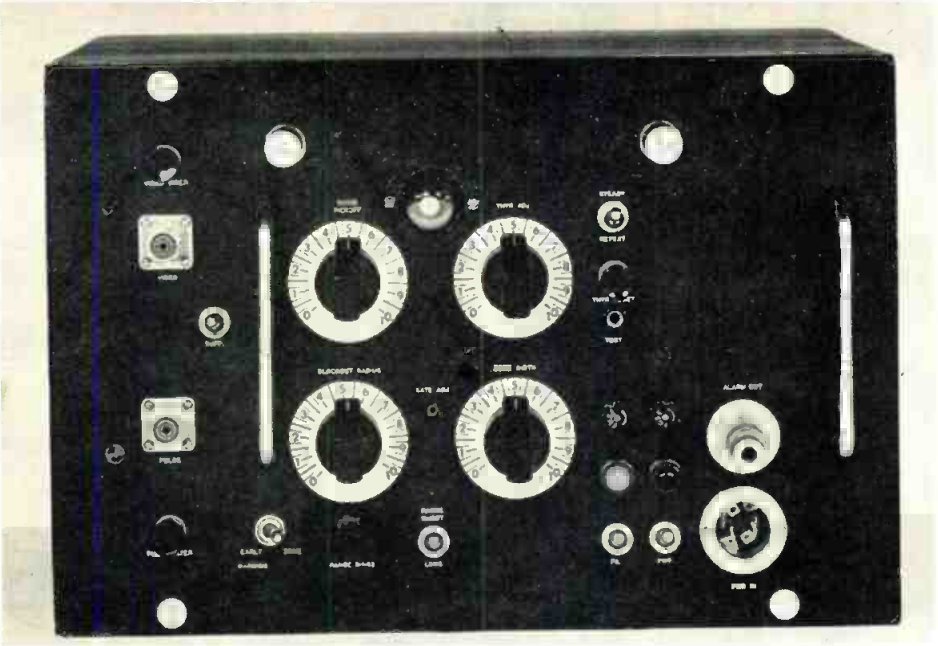


Fig. 1 "Raytector" automatic radar monitor eliminates need for full-time operator

By RICHARD R. MILLER

Reliable, unattended radar operation is provided by equipment which monitors the video output and provides an alarm when target appears in predetermined zone

Automatic Radar Monitor

A DRAWBACK to the use of radar in non-military applications, such as aboard ships, is the need for an operator to continuously monitor the set, although it provides useful information during only a small fraction of the time. This results in two disadvantages; it reduces the efficiency of the operator and hence the effectiveness of the radar set, and it materially increases the operating costs of the radar set.

Author demonstrates shipboard applications of gear to Rear Admiral Gordon McLintock, USMS

The Raytector (Fig. 1) was developed to overcome these problems at a cost within the reach of commercial enterprises. This set automatically monitors the radar set video output and initiates an audible and visual alarm whenever a target appears in a predetermined zone selected by the operator. This frees the radar operator for other duties and increases the dependability of search. As will be described in this article, this equipment can be readily adjusted to operate with any radar equipment and contains built-in test and monitoring circuits to initiate an alarm in the event of failure of either the radar equipment or the Raytector.

Fig. 2 is a block diagram and Fig. 3 a timing diagram of the equipment. As indicated on these diagrams, two signals are required from the radar set. One signal is the triggering pulse which is obtained from the trigger input jack normally located on the indicator unit. The other signal is the video signal which is normally obtained from the video output jack of the radar set. A "T" adapter is connected to both of these jacks (trigger and video output). Outputs from one side of the adapter are fed to the radar monitor. Outputs from the other side are connected so that the signals flow as they did before the Raytector was utilized. Thus the monitor does not affect the usual operation of the radar set.

Timing Circuits

In many installations it is desirable to limit monitoring to a definite zone of operation. For example, in a given installation it may be preferable to eliminate the effects of nearby fixed and visible objects and objects over 40 mi. away. In this case, monitoring can be limited to occur only in the 10-to 40-mi. range. Similarly, any zone at any range can be monitored.

The zone of operation is determined by the timing circuits, i.e. tubes V1 and V3 to V10 in Fig. 2. All timing occurs with reference to the trigger pulse (waveform 1, Fig. 3) obtained from the radar set. This trigger pulse is fed to a cathode follower. The output of the cathode follower includes a potentiometer, P1, which adjusts the pulse amplitude at a value that will trigger the

RICHARD R. MILLER, Miller Associates, Lakeville, Conn.

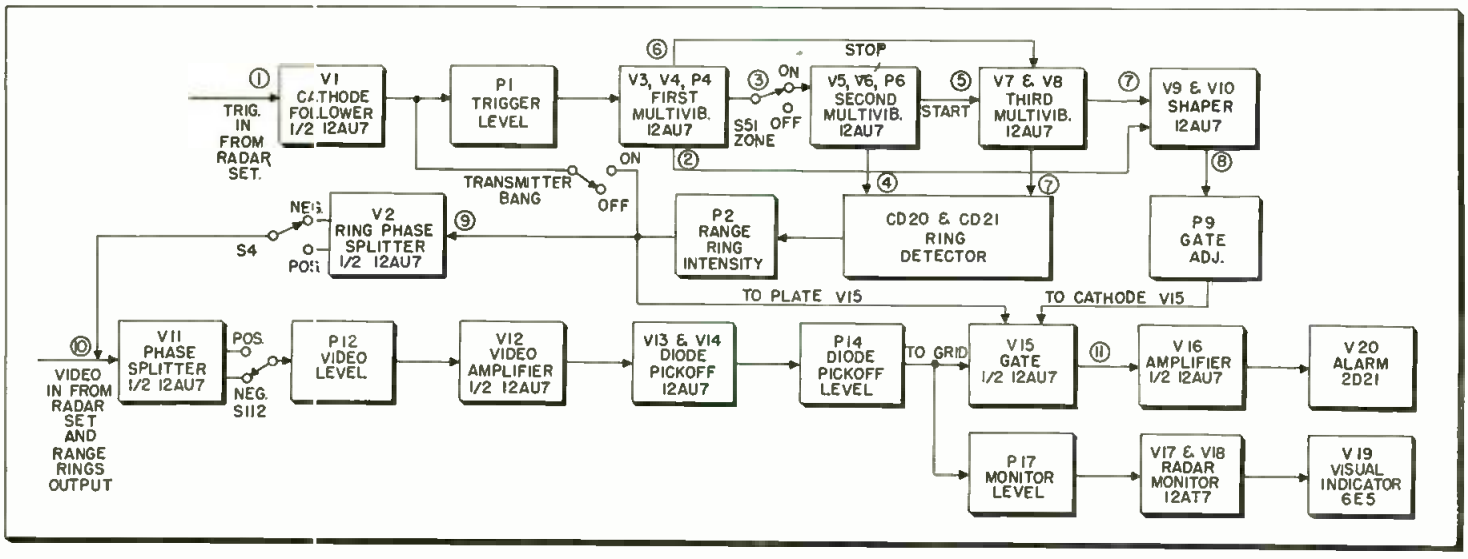


Fig. 2 Block diagram of equipment. Two radar signals are required; the triggering pulse from the indicator unit and the video signal from the video output

first multivibrator, V3 and V4.

V3 and V4, each ½ of a 12AU7 dual triode, are connected as a cathode-coupled, single shot multivibrator. In its steady state condition, V4 is conducting and V3 is cut off. Application of the trigger pulse initiates the multivibrator action causing V3 to conduct and cutting V4 off. After a period of time, adjusted by potentiometer P4 (see waveform 2, Fig. 3), the multivibrator returns to its steady state condition. As will be seen subsequently, this multivibrator determines the beginning of the zone period.

Three waveforms obtained from the first multivibrator are utilized. The first (waveform 2, Fig. 3) is obtained directly from the plate of V4 and consists of a positive pulse starting upon application of the trigger pulse and ending when the multivibrator returns to its steady state condition. The second waveform (3, Fig. 3) is the differentiated output of the voltage obtained at the cathode of V4. It consists of a negative pulse and then a positive pulse, the positive pulse occurring when the multivibrator returns to its steady state condition. The third waveform (6, Fig. 3), is obtained by differentiating and rectifying the voltage at the plate of V3. It consists of a single negative pulse occurring at the same time as the trigger pulse.

The differentiated waveform (3, Fig. 3) obtained from the plate of V4 is applied to the grid of V5 through zone switch S51. Stages V5 and V6 comprise a second cathode-coupled, single shot multivibrator whose action is initiated by the positive pulse. The duration period of this multivibrator is adjusted by potentiometer P6 (see waveform 4, Fig. 3). As will be seen subsequently, this multivibrator determines the end of the zone period.

Two waveforms obtained from the second multivibrator are used. The first (waveform 4, Fig. 3) is obtained directly from the plate of V6 and consists of a positive pulse starting upon application of the differentiated positive pulse and ending when the multivibrator returns to its steady state condition. The second waveform (5, Fig. 3) is the differentiated output of the first and consists of a positive and negative pulse, the negative pulse occurring coincidentally with the end of the multivibrator cycle.

Third Multivibrator

Stages V7 and V8 comprise a third multivibrator. This multivibrator is the flip-flop type. Two waveforms are applied to this multivibrator. One, the differentiated, rectified pulse obtained from the plate of V3 (6, Fig. 3), is applied to the grid of V7. The other, the differentiated output of the V6 plate (5, Fig. 3), is applied to the grid of V8. Whenever a negative pulse is applied to the grid of V7, it cuts the tube off and allows V8 to conduct. Similarly whenever a negative pulse is applied to the grid of V8, it causes this tube to cut off and allows V7 to conduct.

The waveform (7, Fig. 3) obtained at the plate of V8 is a voltage which reached a high value whenever V8 is cut off and a much lower value when V8 is conducting. It can readily be seen from Fig. 3 that application of the radar trigger pulse causes the application of a negative pulse at the grid of V7, allowing V8 to conduct and reduce its plate voltage. Upon application of the negative pulse from V6 to the grid of V8, corresponding to the end of the second multivibrator cycle, V8 becomes cut off and its plate voltage returns to a high value.

Stages V9 and V10, each ½ of a 12AU7 dual triode, comprise a shaper circuit. This circuit is shown in Fig. 4. Note that the plates and cathodes of these tubes are tied together, and that the cathodes are at a high positive potential since they are connected to the B+ supply via resistor R102. The grid of V9 derives its voltages from the plate of V8 (waveform 7 of Fig. 3), while the grid of V10 derives its voltage from the plate of V4 (waveform 2 of Fig. 3). Just prior to the application of the trigger pulse, a high positive voltage is applied to the grid of V9 causing the tube to conduct heavily. This makes the voltage obtained at the output of potentiometer P9 a relatively high positive voltage.

Immediately after the trigger pulse is applied to the monitor, the plate voltage of V8 drops, decreasing the V9 grid voltage. However, at the same time, the plate voltage of V4 also increases, thereby increasing the V10 grid voltage and maintaining the P9 output at the high positive voltage.

At the end of the first multivibrator cycle, the plate voltage of V2 drops, and since the plate of V8 is still at its lower potential, current flow through the cathode circuit of V9 and V10 decreases, dropping the P9 output voltage. This reduced voltage is maintained until the end of the second multivibrator cycle, at which time the voltage at the plate of V8 increases and cathode voltage returns to its high value.

Consequently, the output voltage obtained from potentiometer P9 is a negative pulse which starts at the end of the first multivibrator cycle,

(*Continued on page* 94)

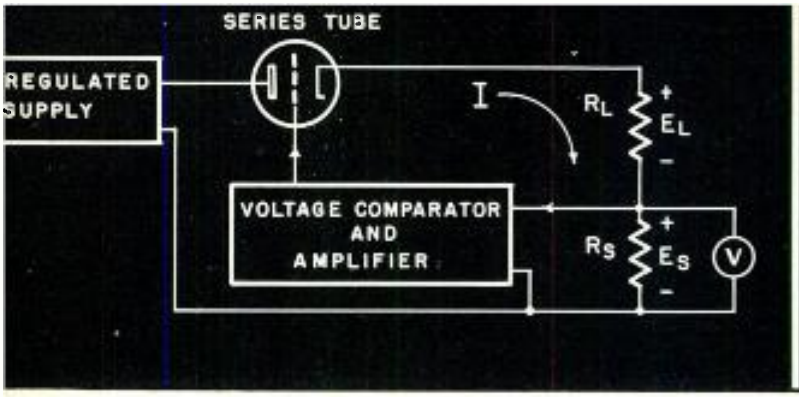


Fig. 1: Block diagram for current regulator

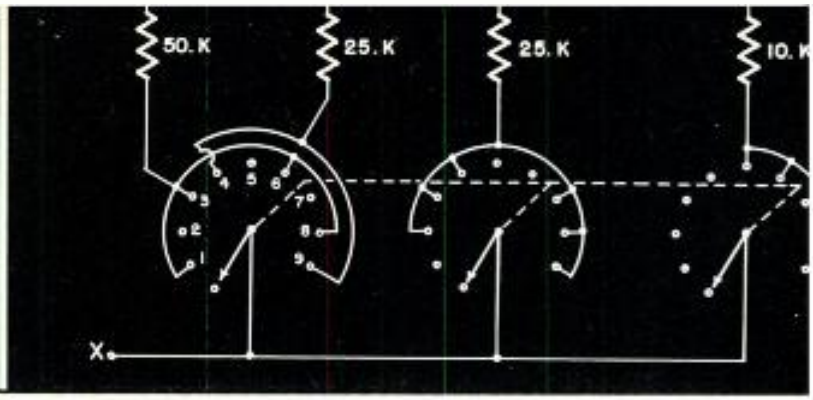


Fig. 2: Single decade switching using 1225 system

Precise Current Supplies

Accurate d-c current is needed for measurements on audio transformers, magnetic amplifiers, saturable r-f tuning elements and other iron core components. This power supply design features foolproof current adjustment, stability, and proper operation indication.

By JOSEPH M. DIAMOND

IN the course of developing measurement techniques for our products we were recently faced with this problem—how to obtain accurate dc currents for measurements on audio transformers, magnetic amplifiers, saturable r-f tuning elements, and other iron core components? This description of the decade control dc current source which we developed for this purpose is given to assist others who may encounter a similar problem.

J. M. Diamond, United Transformer Co., 130 Varick Street, New York 13, N. Y.

In developing a precise source of dc current for measuring purposes, we felt the following to be the three basic requirements:

a. Simple and foolproof adjustment of current, preferably by setting decade dials.

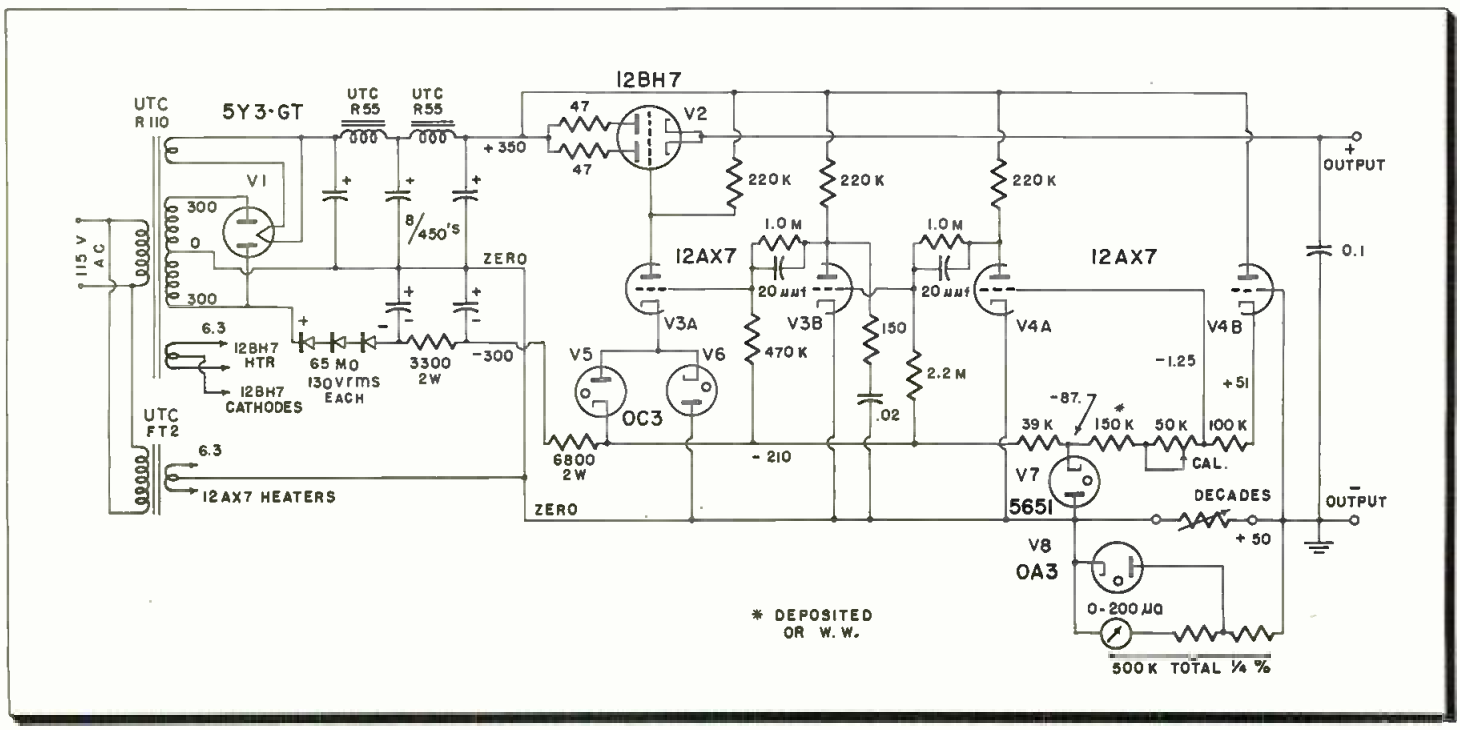
b. Stability with line voltage and load resistance changes.

c. Unmistakable indication of proper operation.

Several regulated current supplies have been built which satisfy these requirements. Fig. 1 illustrates the essentials of operation of the circuit. The voltage drop $E_s = IR_s$, produced by the load current I through the standard resistor R_s, is fed into the voltage comparator and amplifier. There it is compared with a reference voltage, and the difference amplified and fed to the grid of the series tube. The resultant degenerative dc loop stabilizes E_s at a constant value set by design—in the case of the units built, at a value of 50 v. But rather than rely upon the stability of this loop, and of the V.R. tube reference on which it depends, the voltmeter V is included to monitor E_s. Since only a single point on the scale of V need be accurate (e.g., 50 v), an ordinary panel meter can be

(*Continued on page* 109)

Fig. 3: Schematic for 10 ma regulated power supply



Part Three
Of Three Parts

Cut-Off Predictions Via Bandwidth Indexes, Improved Ladder Networks, and Suitable Wide Band Couplers, Aid Amplifier Design

By Dr. Harry Stockman

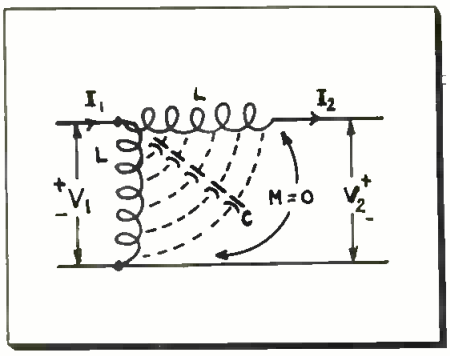


Fig. 6 The electrical wide-band coupling of a traveling-wave transformer

Viewpoints on D-Amplifier Design

Dr. H. Stockman

■ The following discussion applies in general to any termination of plate lines in D-amplifiers, but particular emphasis is given the case when the termination is provided by the grid line of a consecutive D-amplifier stage.

Since we have already discussed the coupling cathode follower, we will first consider this coupling element. The plate-line impedance is generally higher than the grid line impedance, so the cathode follower fits well as an impedance transformer. If a satisfactory "dead end" termination can be assumed in the plate line, an open output end may be tolerated, yielding an extra voltage amplification of two, thanks to the use of the cathode follower. A coupling cathode follower, extending from near dc, may be operated to 100 MC, or so, but in band-pass applications a considerably higher cutoff frequency can be reached. Due to its frequency limitation, however, it appears that the coupling cathode follower has not found much use in the now popular type of D-amplifier, extending to about 200 MC.[12]

In practice, the coupling cathode follower is often connected via proper m-derived sections on both sides, and even in the case of a plate line mismatch to "open" circuit, correcting networks may be inserted.

Direct coupling via a coupling capacitor is the conventional solution when the plate-line characteristic impedance equals that of the consecutive grid line. Direct coupling is also used where there exists an impedance transformation ratio, even in excess of 2:1; extinction of the reflections being trusted to the "dead-end" plate and grid line terminations. As often necessitated by the bias supply circuit, the terminating resistor R_i of the grid or input line may be series connected with a capacitor C_i. Denoting the plate or output line characteristic impedance R_o, with a "dead-end" termination R_o, and denoting the coupling capacitor C_c, we find the condition[17,18]

$$\text{time constant} = R_o C_c = R_i C_i \quad (15)$$

This design criterion tends to yield a smooth transition down towards the dc end of the spectrum.

Expressing the transmission properties of the line-to-line coupling (via a sufficiently large capacitor) by means of the ratio δ of the obtained input voltage of the consecutive grid line to the matched output line voltage, we obtain, for match or mismatch,

$$\delta = \frac{2R_i}{R_i + R_o}, \quad (16)$$

so that the overall voltage gain to the consecutive input line terminals becomes reduced to, for $R_i < R_o$, and to a first approximation,

$$A(\omega)_{tot} = A(\omega)\,\delta = \frac{ng_m R_o}{2} \cdot \frac{2R_i}{R_i + R_o}$$

$$= ng_m \frac{R_i R_o}{R_i + R_o}. \quad (17)$$

For a limited mismatch this coupling method is just as satisfactory as that of the coupling transformer, due to the inherent losses in the transformer. If reflections cannot be tolerated, however, the transformer becomes the desirable choice in spite of this situation.

The Traveling-Wave Transformer: The ideal transformer of winding ratio

$$\sqrt{R_o/R_i}$$

provides the desired 1 : 1 matching, thus zero reflections. With distributed parameters, and referred to as a distributed transformer or traveling-wave transformer, this coupling element may employ magnetic-field action at low frequencies, electric-field action at high frequencies, and both actions over the major part of the frequency band. Each winding of the transformer may be considered as a combination of filter sections, and, in the limit, considered as a peculiar sort of transmission line. The combined magnetic and electric couplings are fundamentally symmetrical and aiding.[19]

A 1:2 or 2:1 auto-transformer, dependent upon the direction of power flow, is shown in Fig. 6. We may think of this transformer as a solenoid, which is folded to form a right angle construction without any loss in magnetic coupling. (In the practical design one winding is positioned on top of the other.) In Fig. 6, however, we ignore the magnetic coupling, and consider the electric coupling only. If the winding turn-to-turn and turn-to-ground capacitances are ignored, and only the last one of the coupling stray capacitances C observed, then

(*Continued on page 99*)

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A separate plant group responsible for "reliable-izing" techniques is seen as key to problem. Methods for boosting reliability are described.

Part Two Of Three Parts

Improving Electronic Reliability

By HERBERT B. BROOKS

ON the assumption, a given tube can safely handle slightly more average current as a direct-coupled amplifier (for example, as the passing tube in a voltage regulator) than as an audio or r-f amplifier. Conversely, tubes used in pulse or class C service should be subjected to a lower average cathode current. This effect is also important in rectifier cathodes,[8] and establishes the maximum peak current rating. The instantaneous heating effect is proportional to current, so for short pulses the maximum safe average cathode current is proportional to the duty cycle. Ordinary tubes seem to operate satisfactorily with peak currents of some fifty times their rated average direct current.

Pulses long compared to the thermal capacity of the oxide surface can cause damage regardless of the average current. Many pulse tube ratings specify maximum pulse lengths in the vicinity of 1 to 5 μsecs, with high peak currents. For moderate peak currents, the pulse length can be safely increased.

Tube ratings are not individually "sharp" and absolute. The maximum rated electrode voltage may be exceeded where the dissipation of all the elements is kept low, and where the impedance and/or d.c. resistance in the grid circuit is kept low. However, it is good practice to operate far short of all limits.[14, 32] It is estimated that failure frequency due to each failure cause varies with the *sixth power* of the magnitude of that cause!

For maximum tube life with normal plate current, heater voltage should be maintained within ±5% of rated value where possible. However, it seems to be the majority opinion[11, 20] that oxide cathode life can be extended by operation at lower temperatures if the plate current is reduced. The following table is based on the emission curve for oxide cathodes:[9]

Reduction of plate current below normal	40%	65%	80%	90%
Suggested reduction of heater voltage below nominal	10%	20%	30%	40%

The heaters of large tubes are started with limited or reduced current. This is sometimes done in complex equipment using many receiving-type tubes.

It is known that intermittent heater operation generally reduces the average operating life. It follows that the tubes should be turned off only when the idle time is expected to exceed some definite period. One source recommends 100% heater voltage for off periods shorter than 15 minutes, 80% for periods up to two hours, and removal of heater power for periods longer than two hours. The relative weight given by this authority to heater life versus interface formation is not known.

Useful tube life is longer in circuits that are designed to function over wider ranges of variation in tube characteristics.[6] This is discussed below.

Vacuum tube types are always developed for specific applications, and all types do not appear to be equally reliable. Very little literature comparing various types is available because each type is intimately associated with the manufacturer who developed it. However, the RCA tube manual (May 1, 1952) cautions against excessive bulb temperature in the 6AQ5. This 7-pin miniature tube is intended to do the work of a 6V6, and accordingly it is rated at some 17 watts total dissipation. Since its bulb area is about half that of a 6V6, it would be surprising if the 6AQ5 were equally dependable.[4, 19, 26, 32] The 6J6 with its common cathode and planar electrode construction was, until recently, outstanding for VHF use, but unbalance between sections, warm-up drift, microphonism, high heater power and low plate dissipation make the 6J6 a questionable choice in most modern designs.[34] There seems to be a general tendency toward somewhat shorter life among tubes with high transconductance.[19, 31]

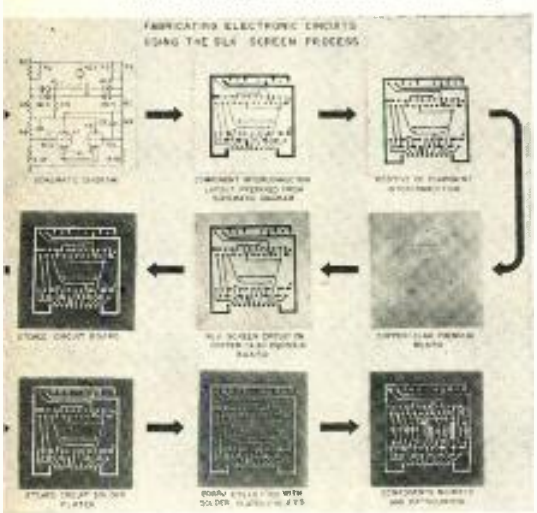
Transistors are potentially reliable because of their resistance to shock and vibration damage and their freedom from heater burnout. Unfortunately, they are still susceptible to temperature and humidity effects, and manufacture with uniform characteristics is a problem.

Ratings of other parts should not be exceeded under the worst combinations of conditions expected. These conditions include the build-up of all tolerances (voltage, pre-warmup surge voltage, tube characteristics, etc.).

Unless space and cost are at an absolute premium, it is good practice to operate capacitors at half their rated voltage, and resistors at ¼ their rated wattage.[30] This will take care of ordinary circuit tolerances and environmental temperatures. Paper capacitor life varies inversely as the fifth power of the applied voltage.[7]

Components which are manufactured at high temperature may be

Printed circuits offer increased reliability



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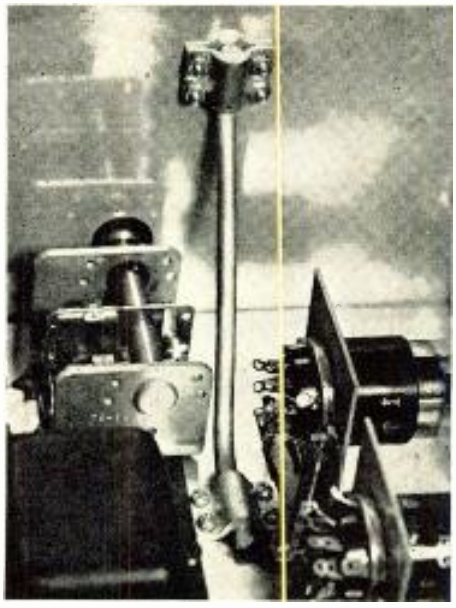

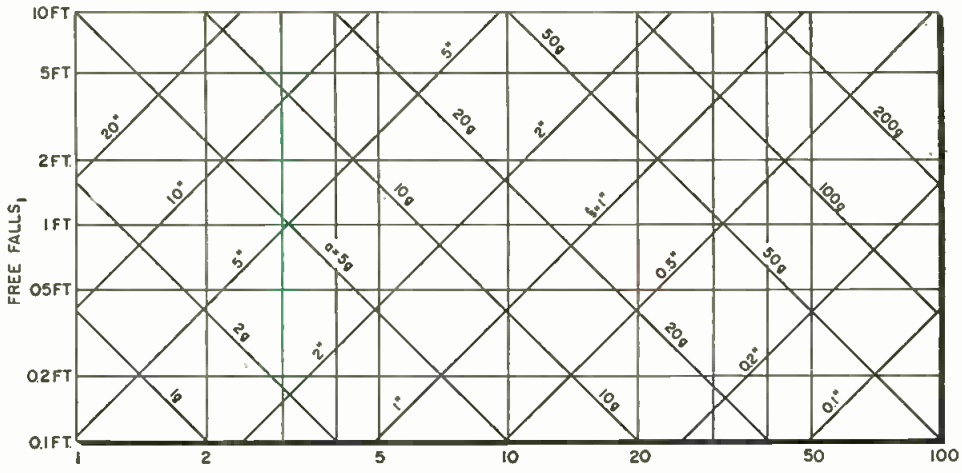

Fig. 3: Peak acceleration in "gravities" and peak displacement for various falls and mounts
Fig. 4: (l) Sealed tube containing refrigerant provides efficient cooling *(Photo—Condor Radio)*

less subject to aging, drift and failure, when operated at elevated ambient temperatures or dissipation levels. This class includes hot-molded composition resistors and ceramic ("Globar") resistors, and ceramic capacitors. Molded potentiometers are widely believed to be more stable and rugged than deposited-carbon film types.

The remarkable dielectric properties of aluminum oxide provide electrolytic capacitors with by far the largest available capacitance per unit of volume, weight, and cost. However, electrolytics are subject to certain important limitations which must be observed to achieve satisfactory operation.[3] Many designers of industrial equipment avoid these limitations by avoiding electrolytics. This measure is not always feasible.

The capacitor current is conducted to the oxide dielectric film by an electrolyte. The equivalent series resistance is 70 to 200 ohms divided by microfarads at room temperature, rising to 2,000 ohms or so at —25°C. The resistance and the temperature effect are lower for low-voltage capacitors, and higher for 450 W.V. models. There is apparently no danger of permanent damage by —60°C temperatures,[28] where 50 W.V. models have only about 700 ohms resistance divided by microfarads.

Ripple current heats the capacitor due to this series resistance. Ripple current up to 100 ma may be safe in 300 W.V. capacitors, but it is prudent to minimize ripple current unless accurate performance information is available for the proposed application.

One type of failure is the development of a virtual short-circuit by destruction of the dielectric. The other common type of failure is a decrease of capacitance and an increase in series resistance due to drying out of the electrolyte. This type of deterioration is hastened by high temperatures (i.e., above 40°C), and is reduced by hermetic sealing.

After an idle shelf period of a year, the initial leakage current rises to several milliamperes. When the capacitor is placed in service, it normally reforms its dielectric film in a few minutes unless the leakage current is high enough to destroy it by overheating.

Idle shelf time causes a slight rise in capacitance. It appears reasonable to assume that de-rating of the applied voltage is as desirable for electrolytics as for other type capacitors. This is contrary to a popular misconception that operation at reduced voltage causes decrease of capacitance with time. This opinion may be based on experience with dried-out capacitors.

Tantalum is now finding use in electrolytics, as a more reliable (and more costly) substitute for aluminum. These can be made very small —suitable for transistor devices.

Component Testing

Where reliability is very important, it may be necessary to test each component before installation. Unfortunately, for wiring, capacitors and certain other components, available tests do not indicate life expectancy with great certainty. A test at elevated voltage will either produce breakdown or not, with no indication as to what damage was done by the test itself. Further development of non-destructive insulation testing is needed.

Heat dissipation must be adequate for reliable operation of electronic equipment. The advertised ratings of nearly all parts apply only up to a certain definite ambient temperature limit (commonly 40°C, or 104°F).[32] With few exceptions, failure frequency decreases steadily as the temperature is reduced. It is easy enough to insert thermometers in critical parts of the circuit to determine whether cooling is adequate.[17] Temperature-indicating paints are available for difficult subjects, such as vacuum tube bulb temperatures.[26] The apparatus must be operated long enough for the temperature to stabilize. This may take an hour for a small device, or a day for a large one. Since the average temperature of the equipment is important, we should avoid mounting germanium products, capacitors, etc. near heat-producers, such as resistors and tubes.

Miniaturization of electronic equipment has sharply increased the importance and the difficulty of heat dissipation. This is one more reason why miniaturization frequently reduces reliability unless strenuous efforts are made to preserve it.

Unless the circuit is quite "open" in construction, reliability depends upon careful consideration by the designer as to how the heat will flow from the major heat sources to the outside of the equipment, and what components it can damage in getting there. The most important means of heat transfer is air flow. Natural convection is often sufficient, and a vertically unobstructed "chimney" design augments the natural convection. Where the natural convection is inadequate, a blower is added. Sometimes an exhaust fan is easier to use, but in

Electronic Reliability (continued)

certain applications the blower type facilitates dust exclusion and the special direction of an air stream on critical components. (See Fig. 4)

It is also desirable to take special precautions to remove heat from certain components. Metallic conduction can accomplish this, and the relative conductivities of certain metals commonly used in electronic construction are listed below:

Silver	1.1
Copper	1.0
Aluminum	0.5
Brass	0.25
Steel	0.12

Where heat is a problem, copper and aluminum have definite merits for chassis and cabinet construction. The copper may be cadmium-plated to reduce tarnishing. Heat dissipation from miniature tubes is inhibited by the conventional type closed shields; close-fitting subminiature tube shields are good if the shield is well bonded to a heat sink.[33]

In paper capacitors, the leakage resistance decreases by half for each 14°F (approx.) rise in temperature.[15]

Circuit Design

The complexity of the circuit or system has a direct bearing on its reliability. The failure frequency is proportional to the number of components in the system. Considering tube failure only, a system containing 300 tubes can be expected to fail every 10 hrs. (average) if the average tube life is 3,000 hours.[2] These averages must be computed on a frequency basis; different values of average life for various tube types cannot be averaged together correctly until they are inverted—i.e. "one failure per 3,000 hours" instead of "3,000 hours average life." It follows that reliability benefits from simplification, where such simplification does not result in a sacrifice of unit or component life. It also follows that effort on reliability is especially urgent for systems which are necessarily complex.

W.W. II popularized many "waveform" circuits, such as the multivibrator and the blocking oscillator. It is now common practice to design by drawing a block diagram meeting the functional requirements, and then filling in the blocks with standard wave-shaping circuits. This appears so easy that the reliability of the resulting system leaves much to be desired until mass production and usage over a period of years have shaken out the marginal designs and "bugs." This need not be so.

Marginal designs can be discovered and avoided before production by carefully and methodically anticipating and analyzing various causes of failure. With practice will come the ability to perform part of the reliability "cleanup" on paper even before breadboarding, but as a first estimate it can be assumed that reliability in a standard circuit should require about as much time and effort as getting the circuit to operate for the first time. In a novel circuit, reliability may require much more effort than does initial success!

For many years, it has been good engineering practice to test electronic devices for proper operation

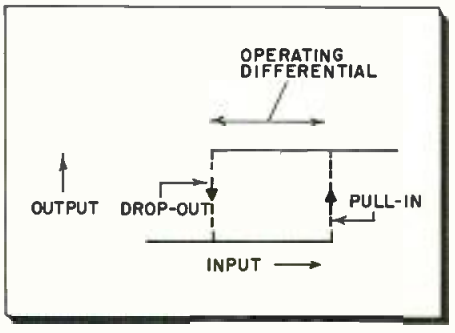

Fig. 5: Decision element with "memory"

at low and high supply voltages, and sometimes for operating life at high voltage. This supply-voltage test is simple and effective, but for best reliability at the earliest possible stage of development, the designer should go much further[6] in devising tests to detect marginal and "tricky" designs. One of these is substitution of "limit" tubes (i.e., with characteristics near the limit permitted by specifications) to reveal tube sensitivity. It takes time to collect a complete set of "limit" tubes unless the available supply is large, but some of the characteristics can be shifted by using an adaptor plug-socket containing parts of suitable characteristics. Transconductance can be decreased by a resistance in series with the cathode. At a single frequency or over a small band, the effective stray capacitance can be lowered by paralleling a choke of suitable inductance.

(In the August issue this article was incorrectly referred to as a two-part feature. Actually, it is being presented in three parts, the third part to appear in the forthcoming October issue of TELE-TECH. The references listed below apply to Parts 1 and 2. Additional references will appear with Part 3.)

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No. 32 — Pulse Delay Nomograph

How to compute delay time in pulse systems using coaxial cable as the delay medium. Practical example facilitates use of nomograph

By JOSEPH F. SODARO

J. F. Sodaro

■ Pulse delay is obtained by transmission through a length of coaxial cable. In this application the coaxial cable is an easily designed delay-line. The delay which results depends upon the cable length, l, and the the dielectric constant, k, of the insulating material. Delay is given by the expression[1],

$$t = 1/3\, l \sqrt{K} \times 10^{-10} \qquad (1)$$

for l in centimeters and t in seconds. The cable impedance is not a factor in this formula.

In the design of this type of delay line, required time delay and the dielectric constant for the available line may be given. To determine the required line length use Fig. 1. Select the values of t and k on the outside scales. A straight line connecting these scale values will intersect the 1 scale at the required cable length. On the other hand the delay time and allowable cable length may be given to determine the cable type to be used. In this case the straight line through t and 1 scale values is extended to intersect the k scale. This intersection shows the cable dielectric constant which is required.

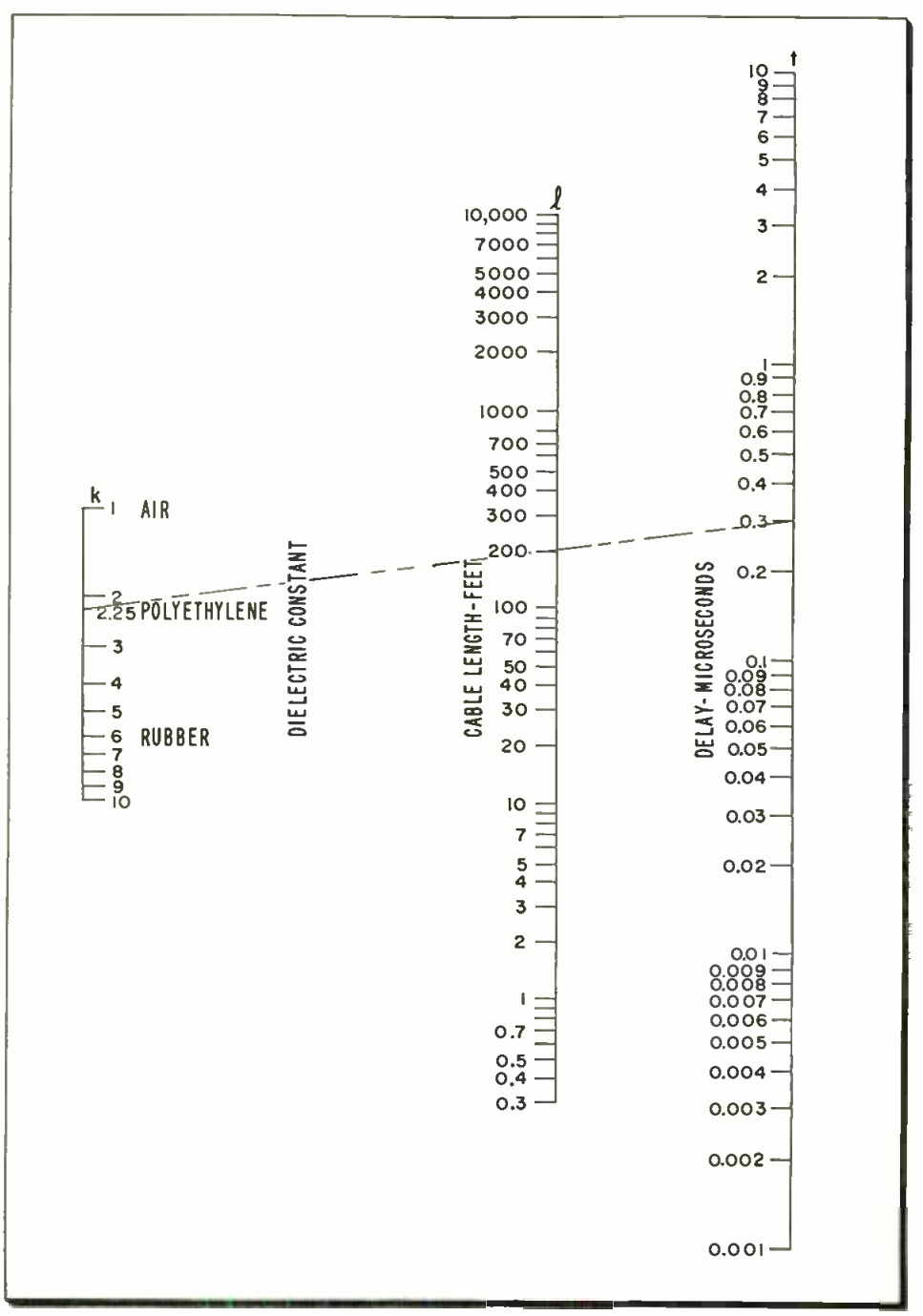
Example

As an example determine the length of cable which will delay a pulse for 0.3 microseconds if the available cable is insulated with polyethylene having a dielectric constant of 2.25. From 0.3 on t to 2.25 on k construct a straight line. Estimate 197 feet where this line intersects the 1 scale.

[1] Blackburn, John F. "Components Handbook" p 192, Vol. 17. Radiation Laboratory Series, 1949 McGraw-Hill Book Co., Inc.

Joseph F. Sodaro, 2924 Selby Ave., Los Angeles 64, Calif. Registered Electrical Engineer in the State of California.

Nomograph illustrates the graphical relationship between the coaxial cable dielectric constant, cable length in ft. and time delay in microsecs.



Desired performance vs cubic volume required are two limiting factors in designing practical folded horns for high fidelity audio reproduction. Equations developed here relate the cubic content of some popular horns to the size governing parameters.

Exponential Horn Design

By J. L. MARKWALTER JR.

J. L. Markwalter, Jr.

■ Horn loudspeakers having good response extending into the lower musical scale are often relatively large pieces of furniture. Performance - governing factors frequently must be compromised because of size limitations. The excellence of a design depends, in part, upon the skill with which the allowed space is utilized.

In proceeding with the layout of a horn, the space problem must be considered from the point of view of either, one, the volume required for a horn giving the desired performance; or, two, the performance which can be obtained from a horn which can be contained within a given volume. In the material following, formulas are derived which relate the cubic content of some popular horn types to the size-governing parameters. By first determining the space occupied by the ideal (prototype) horn, the volume requirement can quickly be estimated for the practical folded horn which is an approximation of the ideal.

The volume of a horn can be found by integrating its cross sectional area over its axial length. For the exponential horn, volume in terms of throat area, flaring constant, and axial length is

$$V = S_t \int_0^{x_m} \epsilon^{kx}\, dx = \frac{S_t}{k}\left[\epsilon^{kx_m} - 1\right] \qquad (1)$$

where

x_m = axial length

S_t = throat area in units of length squared

S_m = mouth area in units of length squared

k = flaring constant in units of

$$\text{length}^{-1} = \frac{4\pi f_o}{C}$$

c = velocity of sound in units of length per second

f_o = flare cutoff frequency in cps

ϵ = 2.718.....

It may be more convenient to determine the exponential horn volume in terms of throat and mouth areas and the flaring constant. The quantity ϵ^{kx_m} is the ratio of the mouth area to the throat area and substituting this into Eq. 1, the volume is

$$V = \frac{S_m - S_t}{k} \qquad (2)$$

and the corresponding length is

$$X_m = \frac{\log_\epsilon \frac{S_m}{S_t}}{k} \qquad (3)$$

Example: Find the volume of an exponential horn having a throat (S_t) of 100 sq. in., flaring constant (k) of .04 in.$^{-1}$, and length (x_m) of 57.5 in. By Eq. 1,

$$V = \frac{100}{.04}\left[\epsilon^{.04\times57.5} - 1\right] \text{in.}^3$$

$$= 2500\,[10-1] = 22{,}500 \text{ in.}^3$$

The expression for the volume of the hyperbolic exponential horn is derived in the same way as is that of the exponential horn.

$$V = S_t \int_0^{x_m} (\text{Cosh } ax + T \text{ Sinh } ax)^2\, dx$$

$$= \frac{S_t}{8a}\left[(T+1)^2\,(\epsilon^{2ax_m} - 1) - 4\,(T^2-1)\,ax_m - (T-1)^2\,(\epsilon^{-2ax_m} - 1)\right]$$

where

a = flaring constant in units of

$$\text{length}^{-1} = \frac{2\pi f_o}{C}$$

T = shape parameter (dimensionless) between 0 and ∞.

(T=0 for a catenoidal horn; T=1 for an exponential horn).

The other parameters have been defined in connection with the exponential horn.

Example: Find the volume of a hyperbolic exponential horn having a throat (S_t) of 100 sq. in., flaring constant (a) of .024 in.$^{-1}$, length (x_m) of 57.5 in., and shape parameter (T) of 0.6. By Eq. 4,

$$V = \frac{100}{8 \times .024}\left[(.6+1)^2\,(\epsilon^{2\times.024\times57.5} - 1) - 4\,(.6^2-1)\times.024\times57.5 - (.6-1)^2\,(\epsilon^{-2\times.024\times57.5} - 1)\right]$$

For the shape parameter, 0.6 has been arbitrarily chosen. The flaring constant of .024 was chosen to give a mouth of 1000 sq. in. for a throat of 100 sq. in. This horn and the exponential horn of the first example have equal mouths, throats and lengths.

The approximate volume required for the practical horn loudspeaker is determined by adding to the volume computed for the ideal horn the estimated content of the horn wall material, sound chamber space, voids, etc. For the first approximation, liberal allowances should be made for wall material and voids. After completing the preliminary layout, the designer should compare the volume of the overall assembly with that of the ideal horn plus sound chamber. This indicates the efficiency with which the cabinet space has been utilized. The relative amount of space consumed in voids depends largely upon the skill with which the packaging has been done. The volume of material contained in the horn walls depends partly upon whether the horn consists of a single or of multiple parallel sound passages.

J. L. MARKWALTER JR. is with the Commercial Products Div., Aircraft Armaments Inc., Cockeysville, Md.

Reference

Leo L. Beranek, *"Acoustics"*, McGraw-Hill Book Company, 1954.

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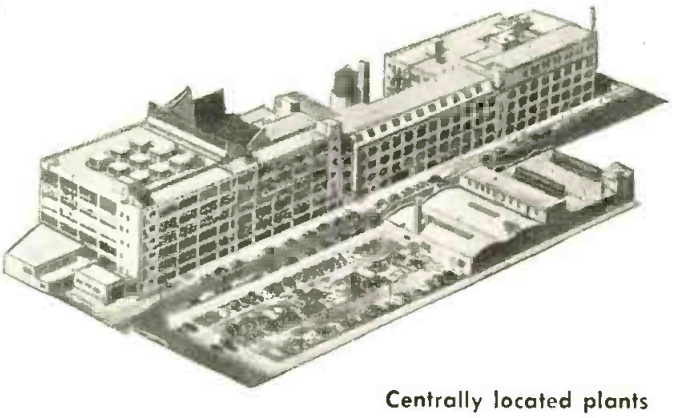

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WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

DIFFICULT PROBLEMS—After their recess for the entire month of August, the FCC Commissioners face not only a heavy workload on all phases of their radio and communications responsibilities but a number of difficult problems in the television field which must be analyzed intensively during the fall months. Major tasks are de-intermixture of VHF and UHF television operations and subscription television as well as working with the Senate Interstate and Foreign Commerce Committee in its investigation of network-UHF television. The Senate body's inquiry, which will reach the stage of public hearings probably in November, is likely to be broadened by outside financial help through a $250,000 grant by the Ford Foundation's Fund for the Republic. This donation which was proposed by Senate Committee Chairman Magnuson (D., Wash.) is slated to be used for fundamental research into freedom of speech in broadcasting, political broadcasting and subscription television.

NEW FCC OFFICIALS—Appointed by the Commission, the new leadership of its Broadcast Bureau—Edward F. Kenehan, a lawyer with both government and radio industry experience, as Bureau chief, and James E. Barr, veteran FCC engineer who has been heading the important broadcast facilities division, as assistant bureau chief—is expected to strengthen the FCC's functioning in its responsibilities over standard and FM broadcasting and television. Mr. Kenehan had 2½ years service with the FCC legal department from 1945 to 1948 and then in its General Counsel's office, during this year. Between 1949 and this year he served three years with a leading Washington radio-communications law firm and from 1951 to 1955 on the legal staff of the Radio Corporation of America's Engineering Division.

MANY IMPORTANT RULINGS—Just as in the case of key issues in the television field which were delayed for determination by the Commission's recess during August, formulation of policies and standards for the industrial communications and mobile radio services by the FCC was likewise in a hiatus until fall. The Commission recognizes that the safety and special radio services represent the largest and fastest growing group of radio users in its jurisdictional field and that their expanding services and problems require "an increasing amount of attention." However, the August recess did have its "silver lining" since it gave the Commission staff of engineers and lawyers in this field relief from the crush of day-by-day tasks an opportunity to consider broad policies and formulation of proposed rules and regulations for these services.

MOBILE RADIO CHIEFS—In its selection of the new Broadcast Bureau top officials, the FCC transferred as a move to place staff executives with valuable experience in key posts the Broadcast Bureau chief and assistant chief to the same positions with its important Safety and Special Radio Services Bureau. The new chief is Curtis B. Plummer who has 15 years service in FCC engineering work—one year 1950-51 as chief engineer and the past four years as Broadcast Bureau Chief as well as work in the field monitoring staff for two years and continuous service at the FCC Washington headquarters in engineering since 1941. The new Assistant Chief is Joseph M. Kittner, a well-qualified FCC lawyer who has been with the Commission since 1941. Mr. Kittner who has risen steadily through the FCC legal department during his career had been mentioned as under consideration by the Senate Interstate Commerce Committee to be its special counsel in the network-television investigation.

FASTEST GROWING SERVICE—Second only to the "daddy" of mobile radio services—police—the Special Industrial Radio Service which has a total of close to 9,000 systems is recorded as the fastest-growing mobile radio operation under the aegis of the FCC regulation. This situation has created "headaches" for the Commission staff since the frequency space for this service has become crowded. Since the needs of the nation's business and industrial enterprises for the use of radio have been proven, the FCC is slated to issue during September new rules and standards for this service. These include a redefinition of eligibility of the service's users and improved operating procedures.

GO OFF AIR—To enable the United States to comply completely with the world allocations regulations, a quarter-century-old radiotelegraph service, California's Federal-State Marketing News Service will cease operations and use of its radiocommunications frequencies by next Jan. 31, the FCC ruled in a decision on the service's occupancy of frequencies below 25 megacycles. The California marketing news service has been the only exception to the 1947 international radio regulations adopted at the world telecommunications conference at Atlantic City.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

POLARAD

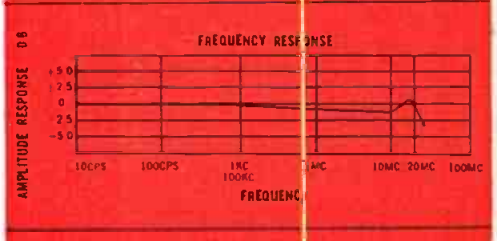
TV EQUIPMENT FOR STUDIO and LABORATORY

WIDE BAND VIDEO AMPLIFIER

10 cps to 20 mc

An oscilloscope deflection amplifier for measuring and analyzing pulses! Extremely wide band with extended low frequency response down to 10 cps. Will accurately analyze television signals. Excellent to increase the amplitude range of your vacuum tube voltmeters and signal generators.

MODEL VIT



The Polarad Wide Band Video Amplifier offers an extremely wide band coverage: flat within ±1½ db from 10 cycles to 20 megacycles per second. It has a time delay of 0.02 microseconds and assures extreme stability because of its associated electronically regulated unit. A low capacity input probe is provided.

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TV STUDIO MONITOR

MODEL M-105

MODEL M-105

The Polarad Model M-105 is portable — comes in sturdy aluminum case, can be rack mounted as well! And it is one of the finest instruments available to check the picture quality of video signals. Equipped with 12½" aluminized kinescope, capable of presenting highest definition transmitted pictures with exceptionally good "sync" stability over a wide range of operating conditions.

PORTABLE TV WAVE FORM MONITOR

MODEL TO-1

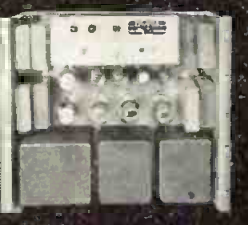
EXCELLENT FOR SUBCARRIER MEASUREMENTS

LOOK AT THESE FEATURES:

1. Can be rack mounted.
2. Can be used for both color and black and white TV.
3. Vertical Amplifier Bandwicth Switch for 2MC, 4MC, 6MC.
4. Special TV Sync. Circuits.
5. Horizonta Sweep Magnification 20 Tube Diameters.
6. Compact and Rugged.

VERTICAL MOUNT REGULATED POWER UNITS

Here are electronically regulated power units completely accessible from the front and back because of their vertical mount design. They have extremely fine regulation, low ripple content and appreciable quantities of D. C. power.



MODEL PT-110

SPECIFICATIONS

	Model PT-110	Model PT-111
Output Voltage DC	400-450 Volts	250-300 Volts
Output Current	150-235 ma	100-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 12 mv rms	Less than 8 mv rms
Negative Supply	—150 V DC; 20 ma	—150V DC; 10 ma
Filament Supply	a. 6.3V @ 12 a b. 6.3V @ 12 a	a. 6.3V @ 12 a AC b. 6.3V @ 12 a
Power Input	105-125V 50/400 cps	105-125V 50/400 cps

MODEL PT-112

SPECIFICATIONS

	Model PT-111D Dual power unit, each side provides:	Model PT-112
Output Voltage	250-300 V DC	250-300 V DC
Output Current	100-400 ma	150-800 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 8 mv rms	Less than 8 mv rms
Line Voltage	105-125V, 50/400 cps	105-125V 50/400 cps
Series Operation		
Output Power	500-600 Volts 100-400 ma	
Parallel Operation		
Output Power	250-300 Volts 200-800 ma	

These features assure dependable, highest quality performance:

- Precise electronic voltage regulation
- Low ripple content
- Does not utilize electrolytic condensers
- Sturdy construction
- Provisions for rack mounting.

Polarad manufactures a complete line of color TV equipment including a Color Slide Scanner, Sync Generator, Bar Generator and Color Monitors.

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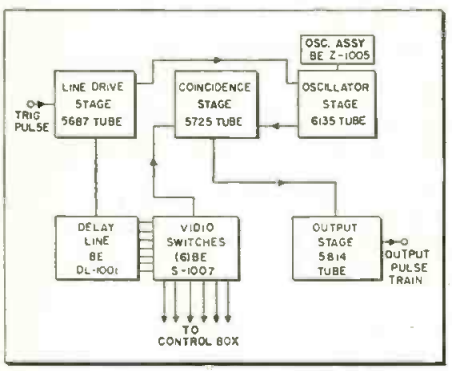
New Avionic Equipment

PULSE CODE GENERATOR

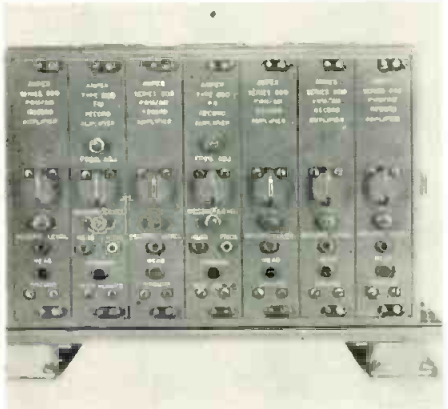
This is a new unit capable of generating pulses for transponder codes used in the Air Traffic Control Beacon System. All requirements spelled out by AECC Characteristic #532 are met by



this generator unit. Temperature range from —40°C to +70°C. Individual pulse positions measured with respect to leading edge of the first framing pulse are in multiples of 2.9 μsec., ±.01. Output pulses measured leading edge to trailing edge are .45, ±0.1. All references at the 50% voltage point. **Brubaker Electronics, Inc., 9151 Exposition Dr., Los Angeles 34, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-53)

TAPE RECORDERS

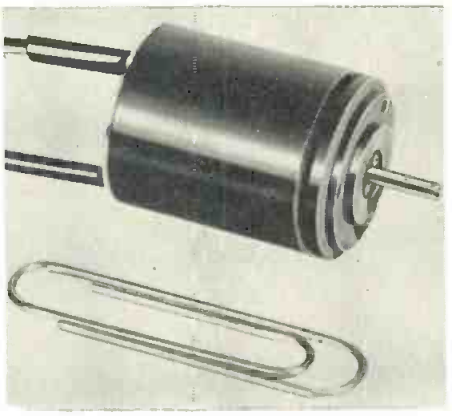
A new series of magnetic tape recorders, known as Series 800, these units are available in models designed to record two channels of information on ¼ in. tape to models intended for 28 tracks on 2 in. tape. Plug-in amplifiers permit recording, on any channel, of pulse-width modulation data, high accuracy transient information, and wide



band direct data. Wow and flutter below .1% rms. Average tape velocity within .1% of specified tape speed. 400 cycle, 115vac and 27.5vdc operation. **Ampex Corp., 934 Charter St., Redwood City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-54)

SIZE 10 SYNCHRO

Type 3G is unusually high permeability miniature synchro, resistant to corrosion due to use of a high nickel alloy for laminations. Spread of angular error is from 20 to 30 minutes. Entire device



weighs only 1 3/4 oz. Length is 1.278 in. and OD is 15/16 in. Type 3G is designed for use in 26 v. 400 cycle systems and is furnished with standard synchro mounting dimensions. For units used as transmitters or receivers, input impedance, Z 110/65°. **John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wisc.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-18)

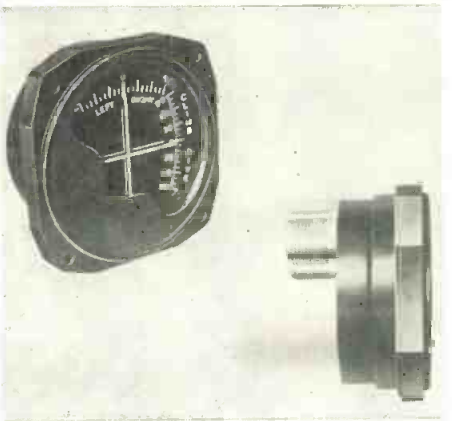
TAPE TRANSPORT

A high-speed, fast start-stop transport, the "Datacord," has been announced for use as an auxiliary memory storage device in computers or data reduction systems that can be mounted in a 19-in. relay rack. Has a tape speed of 75 in./sec. in either direction. Starting and stopping time of the magnetic recorder-reproducer is in the order of 4 msecs. Accommodates tapes varying in widths from ¼ to 2 inches. Any Brush multichannel head can be accommo-

dated. With a Bk-1322 head and a 2-in. tape, 22 channels can be obtained; 44 by interlacing. Reel powered by a 1/2000 hp torque motor. **Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, O.** TELE-TECH & ELECTRONICS INDUSTRIES (Ask for 9-55)

AIRCRAFT INSTRUMENTS

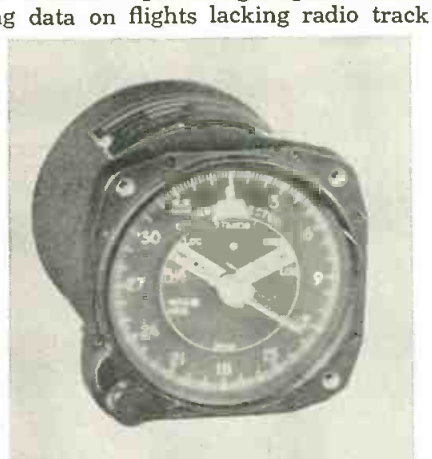
These 2-element instruments meet requirements of Army-Navy Aeronautical Design Standard AND 10401, recently superseded by MS 33550, for 2 3/4 in. dial instruments. Designated AN3C-2E,



they are also available in 1,3, or 4 elements (AN3C-1E, AN3C-3E, AN3C-4E) for applications such as ammeters, voltmeters, temperature indicators, and radio navigational instruments. Miniature coaxial mechanisms used in these instruments possess ruggedness and provide a uniform, self-shielded magnetic field. **Marion Electrical Instrument Co., 401 Canal St. Manchester, N. H.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-20)

COMPASS SLAVED GYRO

Known as the CD-1 Course Director, the new system is designed to provide correct headings for precise instrument approaches and to give accurate enroute tracking on omni and visual-aural VHF ranges. Performs its functions by adding correct azimuth data to the localizer or omni signal and indicating the result on the cross-pointer needle. System will be valuable in providing magnetic heading data on flights lacking radio track



navigational facilities. Power requirements are: 3.5 amps at 14 vdc or 2 amps at 28 vdc. Weighs less than 10 lbs. **Aircraft Radio Corp., Main Rd., Rkwy Val., Boonton, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-4)

New Audio Products

WIRELESS MICROPHONE

Type 127B is an ultra-compact unit specially designed for TV, radio, and motion picture use. Small and light enough (measures just 4 1/2" x 2 1/2" x 1") to be concealed on the person, it

operates in the FM band of 26.110 to 26.470 MC with a 15 kc nominal deviation. A compact battery pack provides a minimum of 5 hours continuous operation. Power output is 75 mw and when used with type 128B receiver, broadcasting transmission (50-12,000 cps, ± 2 db) is achieved over distances of several hundred feet. **Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-22)

TAPE MICROPHONES

Here is a series of omni-directional tape recorder microphones suitable for paging systems and general purpose work as well as tape recording. Light in weight (2 oz.), small in size (3 1/4" x 2 1/8" x 15/16"), and rugged in construction (tenite case), they are available with either shielded crystal or ceramic elements, in gray or biege. Crystal type has a response of 100 to 7000 cycles and an output of —55 db.

Ceramic type has a response of 100 to 6000 cycles and an output of —62 db. Both units are high impedance. **American Microphone Co., 370 So. Fair Oaks Ave., Pasadena 1, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-23)

RECORDING HEADS

The Micro-Gap series of magnetic heads is comprised of Models TR30 and TR35 recording heads and their companion erase heads, Models TE30 and TE35. Models TR30 and TE30 are base

mounted, while Models TR35 and TE35 are rear mounted. Small size makes them suited for miniaturization applications. Model TR35 measures 45/64" from face to the mounting shoulder; Model TR30 is 9/16" from top to mounting shoulder. Both are 31/64" from top to bottom and 21/32" from side to side. **Shure Brothers, 225 W. Huron St., Chicago 10, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-21)

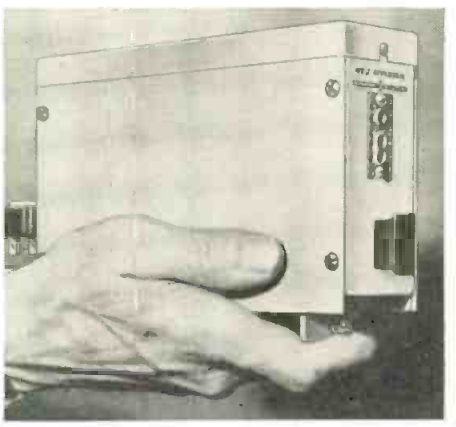
AUDIO BRIDGE

Type 1603-A Z-Y Bridge possesses the prime operational characteristic that it can be balanced for any impedance connected to its terminals. From short circuit to open circuit, real or imaginary, positive or negative, a bridge balance can be obtained with ease. Nominal accuracy 1% from 20 cycles to 20 kc. In addition to measuring R, L, and C components, the Z-Y Bridge is used for measuring impedance fre-

quencies of: electro-acoustic transducers, electrolytic capacitors, transformers and filters, batteries, feedback loops and other devices. **General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-63)

TELEPHONE REPEATER

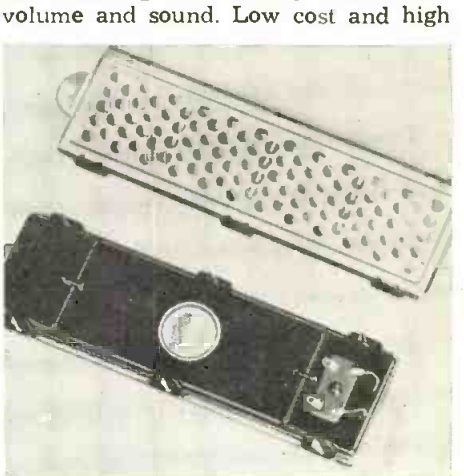
Designated the AT-2, this unit is said to be the first commercially available equipment of this kind to use transistors instead of vacuum tubes. Field tests indicate that it is an economical solu-



tion to the problem of raising telephone voice transmission levels without using heavier cable or wire. These field tests showed that when located near the electrical midpoint of the line, the transistorized repeater provides a gain of up to approximately 10 db. When installed as a terminal repeater, the gain is less. **Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-64)

LOUDSPEAKERS

This is a new ISOPHON line of electrostatic loudspeakers featured in both round and rectangular models. Type St H 5/16 is rectangular and type St H B 7 is round. Both speakers are suggested for use over a frequency range from 7000 to 20,000 cycles. Special construction of the membrane results in far reaching and evenly distributed volume and sound. Low cost and high



quality make this speaker a desirable item for manufacturers of radio, TV, high fidelity and other sound equipment. Made in West Germany. **Arnhold Ceramics, Inc., 1 E. 57th St., New York.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-65)

New Microwave Products

WAVE DETECTOR

Designed to supersede the slotted sections in the range of 100 to 1000 mc/s, the PRD 219 Standing Wave Detector is said to be the solution to making impedance measurements accurately

and easily in this region. VSWR may be read directly on the indicator meter by connecting the output to a VSWR indicator. The reflection coefficient angle is determined by rotating the top drum dial to a minimum indication on the meter and reading it directly in electrical degrees. **Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-57)

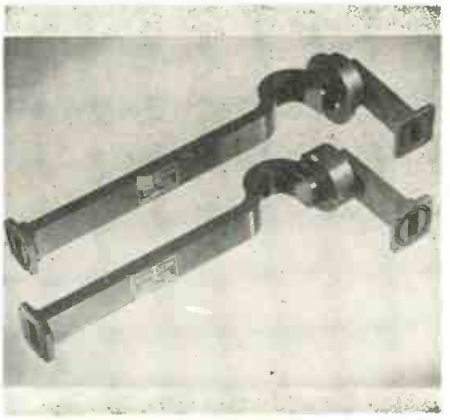
MICROWAVE LINK

"KU Link", a new portable microwave link, has an 11-13 KMC frequency range in common carrier or STL; frequency indicators consist of cavity wavemeters in both receiver and transmitter. Its portability is emphasized by the "suitcase" style housing on all units. Control units may be rack mounted and it has complete receiver RF shielding. Response of the system flat from 60 CPS to 8 MC. Excellent voltage regulation

from 85-135v, 60 CPS. All industry accessories compatible with system, such as parabolas, camera cables, tripods. **Lambda-Pacific Engineering, Inc.**, P. O. Box 105, Van Nuys, Calif. TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-58)

LOAD ISOLATOR

Model X20-L Microwave Load Isolator, designed especially for laboratory use, provides a minimum isolation of 18 db and an average isolation of 25 db over a band extending from 8600 MC



to 9600 MC. Maximum input VSWR with output shorted is 1.5 to 1. By utilizing the resonance absorption characteristics of ferrites, isolator attenuates load reflections without appreciably reducing available power from magnetron or klystron. For higher power use, as high as 20 watts can be applied to isolator with output shorted. **Litton Industries, Components Div., 336 No. Foothill Rd., Beverly Hills, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-10)

WAVEMETERS

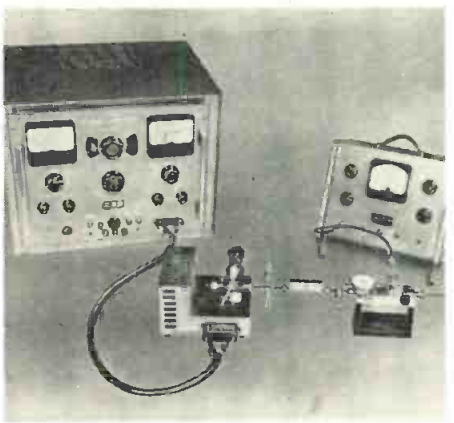
The C&D "S" band wavemeter for the 1,800 MC to 3,800 MC frequency range has the following specifications: Accuracy —½ MC at 3,260 MC/sec. Loaded Q. approx. 1,000. Ruggedized 50 μa indicating instrument. R-F detector is a type 1N21-silicon diode. The Model 230 "C" band wavemeter is a coaxial-line type covering the 3,500 to 6,500 MC range. Has Type "N" constant impedance coaxial connectors for transmission and absorption inputs; BNC or UHF coaxial fitting for external video connection. The Model 228 "L" band wavemeter, a coaxial line instrument, covers the frequency range from 900 to 2,400 MC. **Amerac, Inc., 116 Topsfield Rd., Wenham, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-59)

MORE TECHNICAL INFORMATION

describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

KLYSTRON POWER SUPPLY

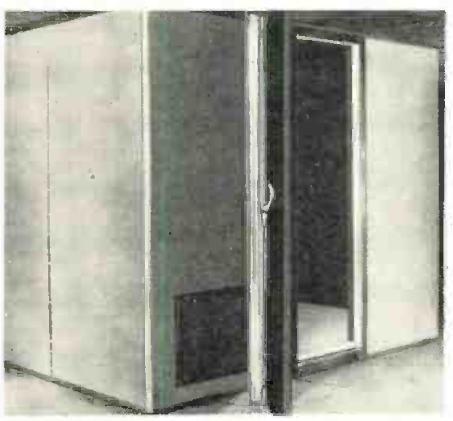
A new and completely specified line of 5 millimeter equipment has just been developed, operating over the full waveguide frequency range of the RG-98/U Waveguide: 50.00 to 75.00 Kilomegacycles per second. A slotted



section, flap attenuator, tunable detector mount, E/H Tuner, frequency meter, termination, sliding short, horn, harmonic generator, bends, tees, transmission line stand, klystron tube mount and power supply are available. Equipment is also available for RG-97/U Waveguide. **Electronics & X-ray Div., F-R Machine Works, Inc.**, 26-12 Borough Place, Woodside, N. Y. TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-60)

SHIELDED ENCLOSURES

The new "Microshield" enclosures for microwave and rf interference applications incorporate two newly designed materials into the basic structure. Lightweight McMillan Hair-Mat Type 8 is used on walls, doors and ceiling. Floor absorption is provided by McMillan Plastic Foam Block Type B,

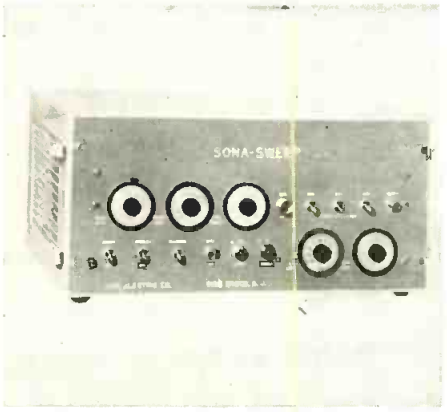


which can be walked on without any loss of electrical characteristics. RF shielding characteristics are not affected by use of these new materials in any way, and attenuation is equal to that achieved without microshield features. **Ace Engineering & Machine Co.**, 3644 North Lawrence St., Phila., Pa. TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-56)

New Test Equipment

OSCILLATOR

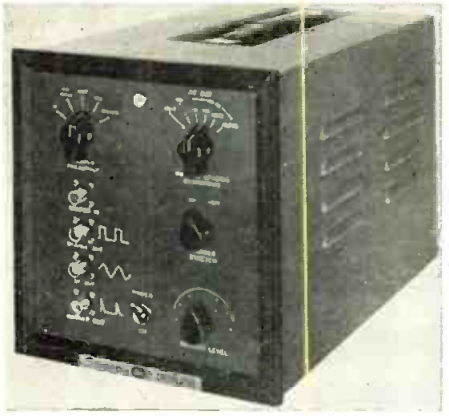
Sona-Sweep Model TV is a keyed sweeping oscillator with sync pulse added for making precision measurements at the low end of the video TV band. Features separate controls on



sync pulse and sweep generator rf output and adjustable equalizer for better than 0.5% accuracy in any one region in the band. Specifications are: Range 0-350 kc; rf output 0-1 v. peak to peak into 75 ohms; flatness of sweep over entire range 1/2%; output attenuator 2, 4, and 6 db for whole signal; variable sweep rate 2 cps to 0.5 cps; sync pulse output 0.3 to 1 v into 75 ohms. Accuracy ± 10 cps. **Kay Electric Co., 14 Maple Ave., Pine Brook, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-7)

SWEEP CALIBRATOR

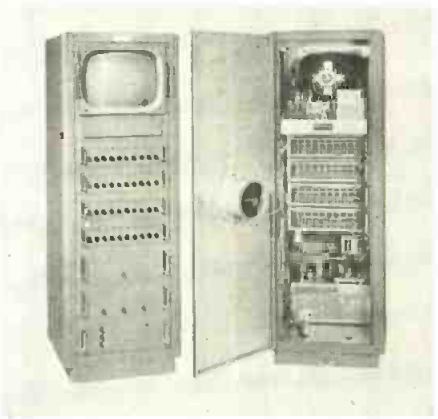
The Model SC-2 sweep calibrator for oscilloscope time base calibration can be used for sweep time calibration, as a marker generator, a counter and computer calibrator, for frequency measurement, as a rectangular pulse shaper, and for frequency response analysis. Produces narrow marker pulses 0.1 usecs wide, spaced at crystal controlled intervals of 1.0, 10.0, 100, 1,000, and



10,000 usecs. Crystal controlled 10 mc, 1.0 mc and 100 kc sine waves are provided through a separate r-f output jack on front panel. **Loral Electronics Corp., 794 E. 140th St., New York 54, N. Y.**— TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-50)

GRAPH OSCILLOSCOPE

Model PW-40 is a 40 channel bar graph display oscilloscope showing a vertical bar graph 9 in. high by 12 in. wide on a 17 in. cylindrical face CRT. Sensitivity: 45 mv peak for 9 in. vertical



deflection; repetition rate: 40 channels each 1/4 sec; frequency response: ± 2% 10 cps to 10 kc, down no more than 3 db at 50 kc. Input system: single-ended with 1 uf coupling capacitor—one side grounded; Input impedance 200 K ohms shunted by 150 uuf approx. Amplifier specs: Four stage feedback, deposited carbon resistors, less than 25 uv RMS noise level, referred to input. **Electro-mec, Inc., 5121 San Fernando Rd., Los Angeles, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-2)

OSCILLOSCOPE

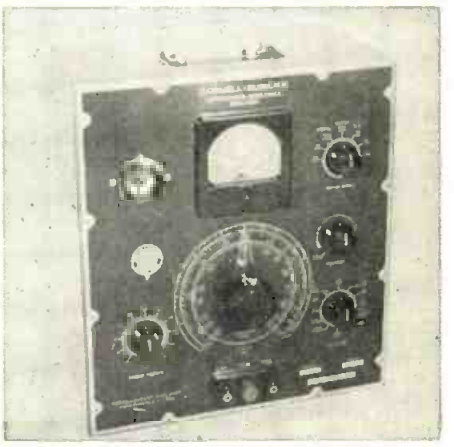
The Model K-26 dual-channel oscilloscope views or photographs virtually any two simultaneous phenomena. Employs two separate, independent channels with signals displayed on the 5-in. screen of a Type 5AFP dual-beam CRT. Sweeps from 2 secs. to 50,000 cps can be selected from the front panel. Frequency response of vertical and horizontal amplifiers is flat to dc. down to not more than 10% at 100 kc. Vertical amplifier deflection factor is 0.025 peak-to-peak v./in. (0.009 RMS v./in.); horizontal amplifiers, 0.3 peak-to-peak v./in. (0.1 RMS v./in.) **Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.** (Ask for 9-51)

MORE TECHNICAL INFORMATION

describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

ANALYZER

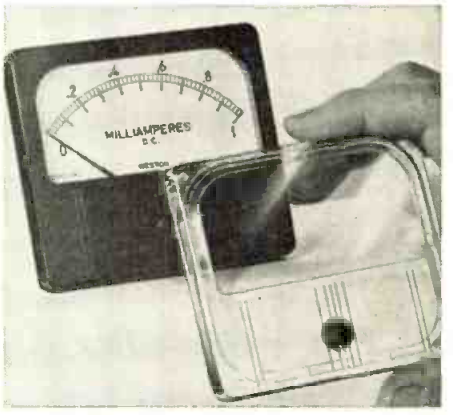
The model BF-70 capacitance-resistance analyzer, for lab, plant and industrial testing purposes, measures the important characteristics of virtually all types of capacitors and resistors. Fea-



tures a direct reading calibration scale that provides simplified measurements, avoiding errors in using multipliers or charts. The built-in panel meter is arranged for independent external voltage measurements to 750 v. and current to 75 ma. Quickly locates capacitor opens, shorts, and intermittents, high and low capacities, etc. Weighs 10 lbs. **Cornell-Dubilier Electric Corp., 1006 Hamilton Blvd., South Plainfield, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-52)

METERS

The Model 1331 line of 3 1/2 in. flush rectangular instruments is a new line incorporating the self-shielded instrument movement. This movement eliminates all inter-effect when instruments are mounted closely on the same panel and permits mounting on magnetic or non-magnetic panels without special adjustment. Instruments have a one-piece snap-on front with zero corrector and the entire front surface,

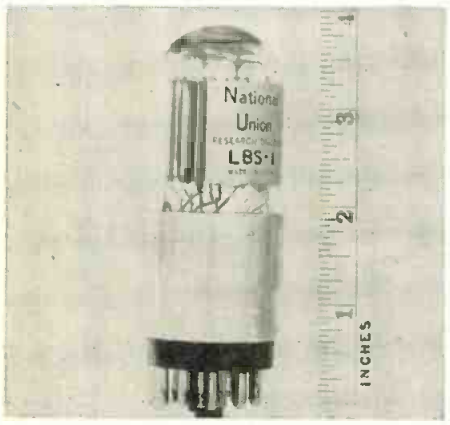


except for the window area, can be supplied in any color. Case dimensions are 3.80 in. x 3.44 in. **Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-13)

New Electronic Products

LINE BEAM SWITCH TUBE

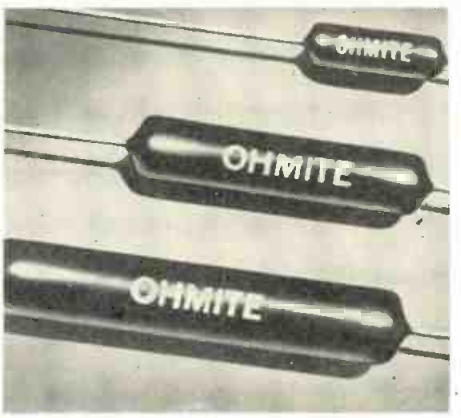
The LBS line beam switch tube is in a T-11 bulb and has a maximum length of 4.25 in. It is intended for high speed commutation of a single electron beam source to a multi-anode target. Ten



separate output anodes are provided. Outputs of 35 v. peak from each anode are obtainable across 100 K load resistors. By placing the unused anodes at B plus, less than 10 anodes can be used. Under normal 300 v. operation with 6ma. of cathode current, the 10 output anodes can be swept with a deflection voltage of 60 v. **National Union Electric Corp., 405 Lexington Ave., New York, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 9-62)

WIRE-WOUND RESISTORS

This is a line of small, power-type resistors having axial leads, steatite cores, and a special-formula vitreous-enamel coating. Resistance wire and terminal lead are both welded to end



cap, assuring perfect and permanently stable electrical connections. "Thermally balanced" parts enable these resistors to withstand high operating temperatures without loosening of terminals or cracking. Smallest resistor is only 1/4 in. diameter by 19/32 in. long overall and is rated at 3 watts. 5 and 10 watt sizes are stocked in a wide range of resistance values. **Ohmite Mfg. Co., 3678 Howard St., Skokie, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-14)

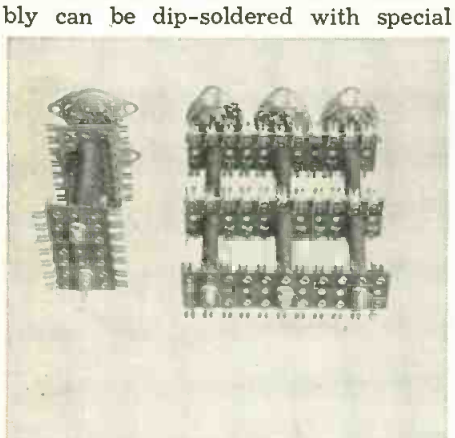
PANEL SEAL

Model 3268 panel seal for toggle switches exceeds the requirements of Spec. MIL-B-5423 in sealing out water, dust, moisture, explosive or combustible liquids, vapors and gases, and in resist-

ing ozone attack. It also acts as a locknut in securing the toggle switch to the panel. The silicone-base rubber membrane has the following characteristics: Temp. range $-60°C$ to $+200°C$; Elongation factor 300%; Tensile strength 750 psi; Durometer 45 to 60; Tear strength 90 lbs. Available in 5 colors (tan, red, gray, white and black). **Panseal, Inc.,** 10 Main St., Little Ferry, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-61)

DECK TURRET SOCKET

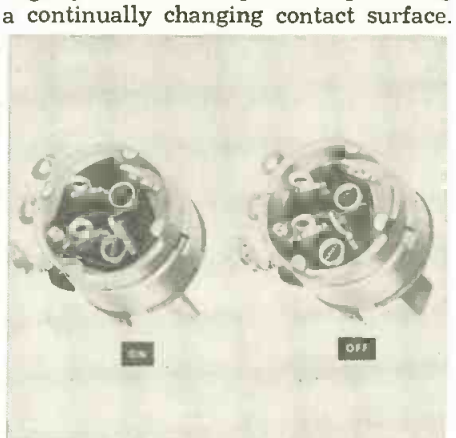
Featuring "Zip" terminal that holds leads firmly until soldered, these sockets are available in sizes from 1 to 6 tubes using any socket and come in XXXP phenolic, glass silicone, or glass epoxy. "Zip," a fork type terminal with inner edges serrated, holds the component part firmly for both an electrical and mechanical contact. Entire assembly can be dip-soldered with special



component arrangements. For strapping between terminals, one fork of Zip terminal is slipped over a mating tongue on adjoining one. **Vector Electronic Co., 3352 San Fernando Rd., Los Angeles, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-15)

VOLUME CONTROL SWITCH

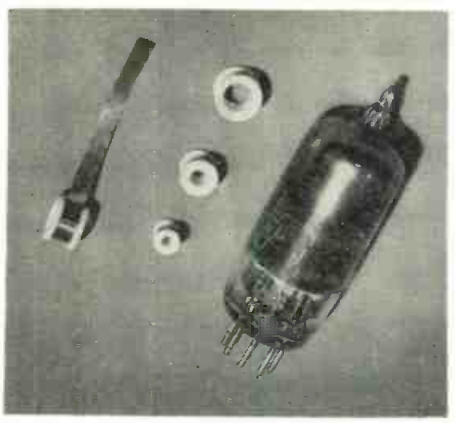
This is a new type of rotary switch employing a unique "floating ring" contact action. Make or break of the line circuit is accomplished by spring-snapped, self-aligning motion of rings of special contact alloy. The rings "float" on pins so that they can rotate slightly with each operation providing a continually changing contact surface.



Wear and arc erosion are spread around the whole circumference, make and break action positive, switch life is extremely long. **P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-32)

MAGNETIC CORES

Designed for high speed switching and computer type circuits, this line of tape wound magnetic cores has a high degree of uniformity. The cores are available in ⅛ mil and ¼ mil thicknesses in 4-79 Molypermalloy and Orthonik. Thicknesses in ½ mil and 1 mil are also obtainable in Orthonik. Tape widths are ⅛ and ¼ inches, and bobbin sizes range from ⅛ to ¾ in. The cores are made with close tolerance



limits on (1) dc coercive force, (2) squareness ratio, (3) flux change, and (4) switching time. **Electronic Instruments Div., Burroughs Corporation,** 1209 Vine, Phila., Pa. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-81)

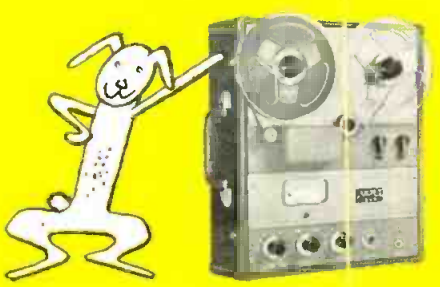
announcing

the new Ampex 610 and 612

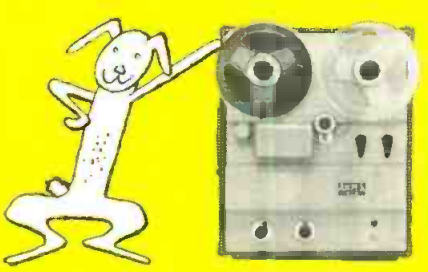
the best now begins at $344...and with this new price comes a smart idea on complete tape equipment for the broadcast or recording studio

Both have all the extraordinary quality and reliability of the Ampex 600 Tape Recorder. They cost less because they are reproducers only. They eliminate chance for accidental erasure—hence are ideal for editing, copying, program auditioning, sales demonstrations and broadcast playback. The Ampex 610 plays half-track and full-track tapes. The 612 plays these and two-track stereophonic as well.

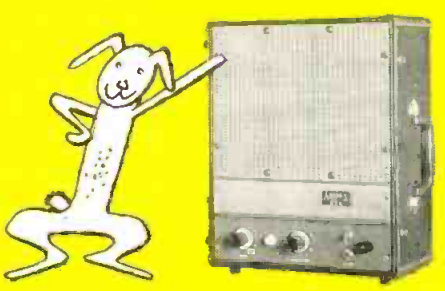
NOW YOU CAN BUY THIS matching family of three FOR THE PRICE OF THE PROFESSIONAL CONSOLE RECORDER



AMPEX 600 — The tape recorder that combines ultra fidelity, timing accuracy, reliability and portability. It has successfully brought the Ampex Standard of Excellence within reach of every broadcast station. Prices are $498 chassis for rack mounting or $545 in portable case.



AMPEX 610 or 612 — The new tape reproducers that have identical characteristics to the Ampex 600. Prices of the 610 (half-track and full-track) are $344 chassis only and $359.50 in portable case or contemporary furniture cabinet. Prices of the 612 (half-track, full-track, and two-track stereophonic) are $379.50 and $395 respectively in same mountings as above.



AMPEX 620 — A companion amplifier-speaker for either 600, 610 or 612 that matches them in portability, appearance and quality. It provides compelling "live sound" demonstrations for selling station programs or spots (and also can be a sensitive station monitor). Prices are $149.50 in portable case, or $169.50 in contemporary furniture cabinet.

For full specifications, write Dept. U-2294

AMPEX CORPORATION

SIGNATURE OF PERFECTION IN SOUND

934 CHARTER STREET · REDWOOD CITY, CALIFORNIA

Distribution in principal U. S. cities (listed in your classified directory under "Recording Equipment"); distributed in Canada by Canadian General Electric Company.

New Tech Data for Engineers

Resumes of New Catalogs and Bulletins Offered This Month by Manufacturers to Interested Readers

High Voltage Power Supply

Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J. has recently published a brochure announcing model N401, its new high voltage power supply. (Ask for B-1-9)

Ceramic Coating

Frenchtown Porcelain Co., Trenton, N. J., has available bulletin 155 on Nicote metallized ceramic coating for use with both hard and soft solder ceramics. (Ask for B-2-9)

Measuring Instruments

"Precision Electronic Measurement and Control Instruments." a new condensed catalog available from Byron Jackson Co. Electronic Division, 492 E. Union St., Pasadena, Calif., describes their line of signal generators, VSWR indicators, incidental FM meters and vibrotron digital pressure gages and accessories. (Ask for B-3-9)

Relays

Catalog H, giving complete specifications and illustrations of all popular types of relays and timers, is offered by Struthers-Dunn, Inc., Lambs Rd., Pitman, N. J. This is a 20-page catalog describing some 5,348 combinations of relays. (Ask for B-4-9)

Computer

A 12-page brochure on the READIX, a general purpose, fixed and floating point computer designed for business data processing, scientific computation, data reduction or automatic control, is offered by the J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif. (Ask for B-5-9)

Electron Microscopes

The Research and Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. is offering a new 8-page booklet titled "Questions and Answers on Electron Microscopes." This material was prepared specifically to answer questions that are frequently raised in the field concerning operation and application of these instruments. (Ask for B-6-9)

Tape Recording Mechanisms

Project Digest No. PD-18 issued by Cook Research Laboratories Div. of Cook Electric Co., 2700 N. Southport Terminal, Chicago, Ill., illustrates and describes the various magnetic tape recording mechanisms developed by the company. This bulletin also gives complete specifications and applications of the various mechanisms developed. (Ask for B-7-9)

Coaxial Cable

Bulletin CT, a 4-page bulletin issued by Phelps Dodge Copper Products Corp., 40 Wall St., N. Y. gives specifications and graphic illustrations of their Spirafil coaxial cable, semi-flexible and aluminum sheathed, for broadcast, communications, microwave and community antenna. (Ask for B-8-9)

Hermetic Seals

Advanced Vacuum Products, Inc., 18 Liberty St., Stamford, Conn., has available a 4-page bulletin on hermetic seals for temperatures to 1400°F and for pressures to 2000 PSI. (Ask for B-9-9)

Tubes

Radio Corporation of America, Tube Dept., Harrison, N. J., has available two new bulletins on beam power amplifiers. One is on their 2E26 VHF amplifier, intended primarily for use in FM Transmitters and the other is on their 2E24 VHF amplifier, designed for mobile and emergency communications equipment. (Ask for B-10-9)

Parabolic Antennas

Prodelin, Inc., 307 Bergen Ave., Kearny, N. J., has available a bulletin on a new line of spun aluminum type Parabolic Antennas for the 890-960 and 1700-2110 ranges in 2, 4, and 6 foot sizes. (Ask for B-11-9)

Potentiometer

DeJUR-Amsco Corp., 45-01 Northern Blvd., L.I.C., N.Y., has released bulletin K200-455, a two-page illustrated color bulletin covering features, technical data and outline drawing of new high resolution potentiometers designed for low torque, high function angle applications. (Ask for B-12-9)

Laboratory Instruments

Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J. is offering a fully illustrated new catalog A46A describing their laboratory standard instruments and standard cells. Also included is expanded information pertaining to the Model 326 Voltmeters, Ammeters, and Wattmeters. (Ask for B-13-9)

Space Winder

A new catalog sheet is available from Geo. Stevens Mfg. Co., Pulaski Rd. at Peterson, Chicago, Ill. One side illustrates and completely describes Model 418-AM Automatic Variable Pitch Space Winder and the other side of the sheet illustrates Model WS-1 Wire Insulating Equipment, also giving complete information. (Ask for B-14-9)

Electronic Components

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass., has made available its new comprehensive catalog, No. 500, which supercedes all catalogs of previous issue. It includes complete specifications, actual size illustrations and schematic drawings of all CTC's standard electronic and electrical components. (Ask for B-15-9)

Magnetic Components

Bulletin 4-100, a 16-page booklet published by Raytheon Mfg. Co., 100 River St., Waltham 54, Mass., describes in detail the wide variety of specialized magnetic components produced by them for use in all types of electrical and electronic equipment. (Ask for B-16-9)

Printed Circuitry

A 12-page, 2-color bulletin using photographs, schematics and tables to illustrate the advantages of printed circuitry over conventional hand-wiring methods, is again available in a 2nd edition from National Vulcanized Fibre Co., Wilmington 9, Del. (Ask for B-17-9)

Transformers

Catalog TR-55 published by Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif., gives complete specifications on a new group of hi-fidelity output transformers with screen taps in the primary. (Ask for B-18-9)

Connectors

A 34-page catalog, No. 255A, with illustrations, graphs and tables, describing flare type connectors for styroflex cable, is available from Communication Products Co., Inc., Marlboro, N. J. (Ask for B-19-9)

Precision Meter

The Instrument Division, Federal Telephone And Radio Co., 100 Kingsland Rd. Clifton, N. J. is offering a catalog sheet giving description and specifications of their new type RGV Resistance Precision Meter, to any who would like a copy of it. (Ask for B-20-9)

Connectors and Cable

Bulletin 355 is offered by Communication Products Co., Inc., Marlboro, N. J. showing their styroflex connectors and cable for use in AM broadcasting. (Ask for B-21-9)

Air Line Connectors

Cannon Electric Co., 3209 Humboldt St. Los Angeles, Calif., has made available Bulletin SR-AL-1, illustrating a new line of manometer pressure air line connectors. (Ask for B-22-9)

Germanium Rectifiers

A newly-published bulletin, GPR-1, listing ratings and specifications on germanium power rectifiers is available from International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. (Ask for B-23-9)

Tape Recorder

Magnecord, Inc., 1101 So. Kilbourn Ave., Chicago, Ill., manufacturers of professional tape recorders, is offering a booklet outlining 207 valuable uses for a tape recorder in today's modern living, at home or away, at work or at play. (Ask for B-24-9)

Current Transformers

A new combination of rectifier ac ammeters and split-core current transformer with 50 ma secondary which permits ranges of 0-25/50/100/200 amps, 25-400 cycles are described in bulletin 455 made avaiable by the Esterline-Angus Co., Inc., P.O. Box 596, Indianapolis, Ind. (Ask for B-25-9)

Flame Photometer

A new 4-page folder that gives design data on the new Norelco Flame Photometer (Type 12130) has been published by the Research and Control Instruments Div. of North American Phillips Co., 750 So. Fulton Ave., Mount Vernon, N. Y. (Ask for B-26-9)

TV Transmitter

Allen B. Du Mont Laboratories. Clifton, N. J., is offering bulletin TR-884 giving the specifications and illustrations of the Series 100-50 watt transmitter, covering channels 2-6, and the Series 200-50 watt transmitter, covering channels 7-13. (Ask for B-27-9)

Relays

A new relay catalog, No. 55, published by Magnecraft Electric Co., 3350 H. W. Grand Ave., Chicago, Ill., includes all types of relays for many applications and also illustrates and gives dimensions of many popular hermetically sealed and dust-proof enclosures. (Ask for B-28-9)

Transformers

Milwaukee Transformer Co., 5231 N. Hopkins, Milwaukee, Wisc., has available a 15-page catalog listing the various transformers and magnetic components manufactured by them. Case dimensions and ratings of many of the company's stock types are given and illustrated. (Ask for B-40-9)

Radar Transformers

Oil filled transformers and inductors for radar and other electronic applications are described in a new 12-page bulletin, GEA-5963, offered by the General Electric Co., 1 River Rd., Schenectady, N. Y. Design features of the regular production models are fully described. (Ask for B-41-9)

Motor Generator Set

Kato Engineering Co., 1415 First Ave., Mankato, Minn., has available a bulletin on a new 380-420 cycles variable frequency motor generator set, giving illustrations and complete specifications on the unit. (Ask for B-42-9)

Magnetic Cores

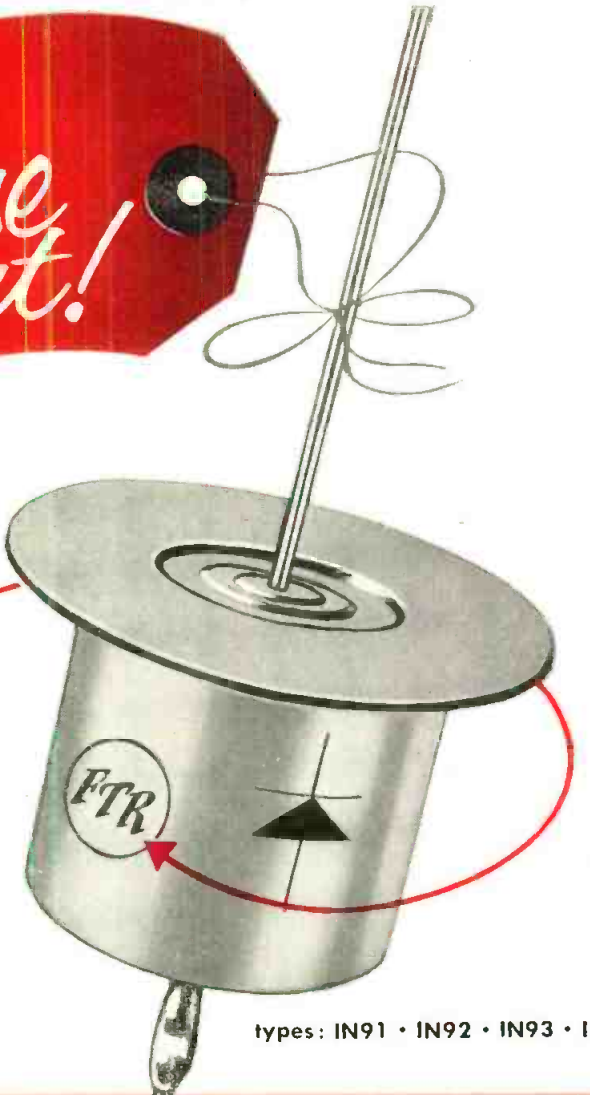
A 4-page bulletin on ferramic magnetic cores is available from General Ceramics Corp., Keasbey, N. J., giving specifications and data on standard grades of Ferramic "H". (Ask for B-43-9)

Selenium Rectifiers

Catalog No. 127 is a new booklet entitled "A Guide to Better Plating Power," published by the Bart-Messing Corp., 229 Main St., Belleville, N. J. This booklet illustrates and gives specifications and data on selenium rectifier design to provide dc power for every electroplating, electropolishing, electrocleaning and electrochemical need. (Ask for B-29-9)

20% less reverse current!

with Federal germanium power rectifiers



types: IN91 • IN92 • IN93 • IN368

The benefits of Federal's exacting standards of fabrication and testing are now within reach of every user of germanium rectifiers. Federal craftsmanship assures at least *20% lower reverse current than the RETMA specifications for every IN91, IN92, and IN93 rectifier.*

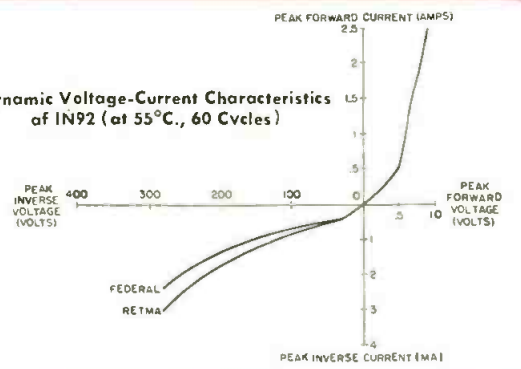
FEDERAL, pioneer developer and manufacturer of semi-conductor products, has just completed a major expansion of its germanium rectifier production facilities . . . NOW, production quantities of diffused junction rectifiers are available for general industrial use.

ELECTRICAL RATINGS

(based on 55° C ambient T$_a$, resistive loads, 60 cycle input)

CHARACTERISTIC	IN91	IN92	IN93
Peak Inverse Voltage, Max. (volts)	100	200	300
RMS Input Voltage (volts)	70	140	210
RMS Input Voltage (capacitive load) (volts)	35	70	105
DC Output Current, Max. (ma.)	150	100	75
*Leakage Current at Rated Peak Inverse Voltage (ma) (Retma Limits)	*2.7	*1.9	*1.2

*Limits established by Federal assure at least 20% less leakage.



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Ferromagnetic Cores

(*Continued from page 59*)

loop can be approached. The solid curve indicates the extent to which the "inside" corners can be rounded while the "outside" corners remain essentially the same.

Considerable effort is being expended to achieve a more fundamental understanding of the causes behind these variations. Fortunately, however, variations to the extent shown in Fig. 6 have no appreciable influence on the reliable operation of the magnetic core as used in pulsed magnetic core circuits. Magnetic cores exhibiting more extreme variations in the roundness of the corners are accompanied by a reduction in squareness ratio and are rejected on the basis of the squareness ratio as determined by the method indicated in Figs. 3 and 4.

Squareness Ratio.

Squareness ratios from 0.92 to as high as 0.98 have been measured for the major d-c hysteresis loops of the metal tapes being discussed. The squareness ratio as measured by the method indicated in Figs. 3 and 4 is influenced by the magnitude of the applied pulse magnetizing force. Fig.

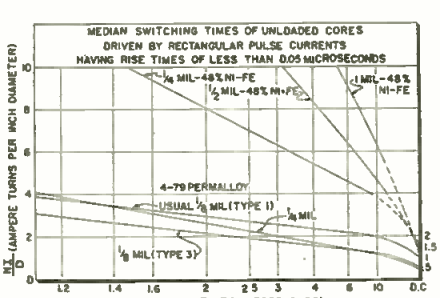

Figure 9

7 shows a graph of median value of squareness ratio as a function of applied pulse magnetizing force for ⅛-mil 4-79 Permalloy cores. The squareness ratio is maximum at the lowest value of NI/D which causes saturation. The gradual decrease in squareness ratio for higher values of NI/D is due to the non-zero slope in the region of saturation.

Flux Change.

The amount of total flux change possible in a core is a function of the basic magnetic material and its cross-sectional area. The flux change for a given magnetic material will thus be proportional to the number of wraps of tape wound on the core bobbin. Therefore the tolerance that can be achieved for flux change from one core to another is a direct function of (1) the tolerances to

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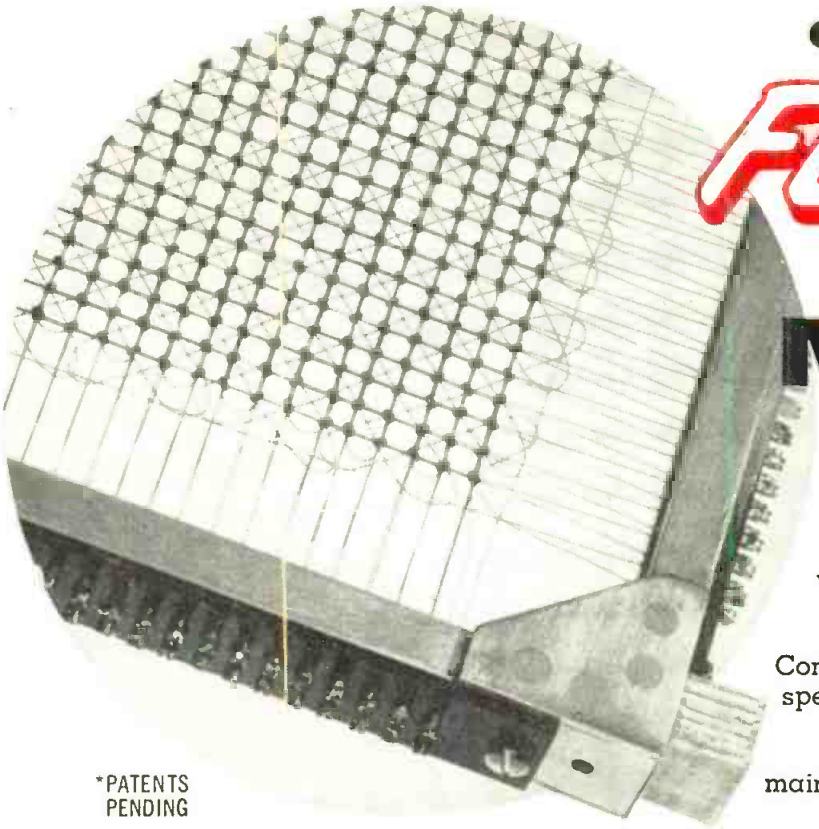

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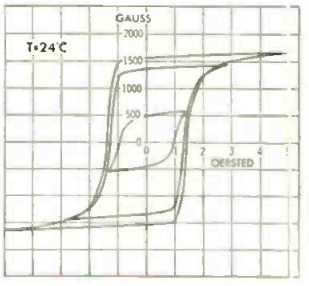

Diagram illustrates flux-current characteristics of ferrite toroid with nearly rectangular hysteresis loop. In addition to high volume resistivity and low loss factor, high efficiency is maintained at both high and low frequencies. Response time is approximately 1.0 microsecond.

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.025" THICK	.030" THICK	.125" THICK

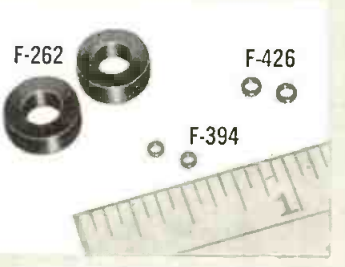

TABLE OF MAGNETIC PROPERTIES

		FERRAMIC "S-1"	FERRAMIC "S-3"
Initial permeability (1 Mc)	μ_o	40	45
Maximum permeability (DC)	μ_{max}	515	1800
Saturation Flux Density (DC) gauss	B_s	1780	2000
Retentivity (DC) gauss	B_r	1590	1920
Coercive Force oersteds	H_c	1.5 max.	.65 max.
Switching Time microseconds	τ	1	>4
Br/Bs Ratio		0.90	.96
Maximum Squareness Ratio $\frac{\Phi(=Im)}{2}/\Phi(Im)$	R_s	0.8	.95
Optimum Magnetomotive Force (oersteds)	H_m	2.0	.80

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Ferromagnetic Cores

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which the rolling and slitting process can be controlled and (2) the accuracy with which a specified number of wraps can be applied to the bobbin. By specifying the desired value of flux change for a given core, rather than the number of wraps of material, the number of wraps can be adjusted to compensate for known variations in the cross-sectional area of the tape. Since the range of annealing cycles used for acceptable cores has been

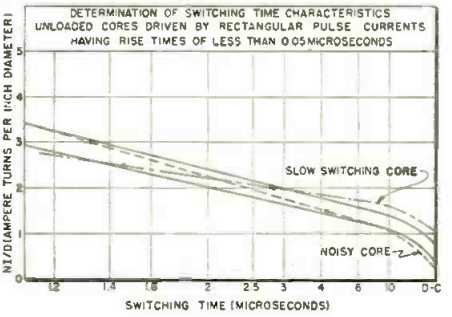


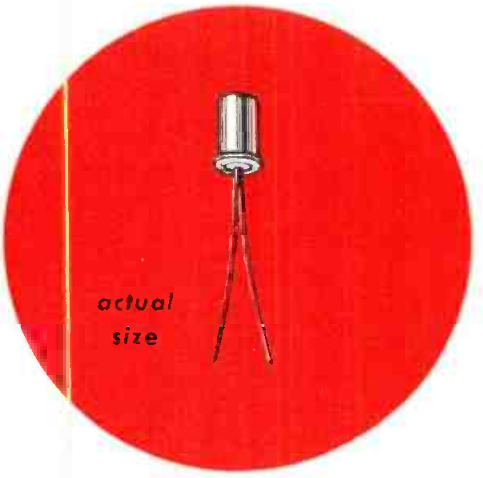
Figure 10

determined to have only minor effects on the flux change, the overall tolerance that can be achieved for flux change is essentially determined by the accuracy of the wrapping process. Tolerances in flux change of 20%, total, have been achieved at the present time without great difficulty.

The flux change for a given core, as measured by the method indicated in Figs. 3 and 4, varies slightly as a function of the applied pulse magnetizing force. Fig. 7 shows this variation for ⅛-mil 4-79 Permalloy cores. The value of flux changed within a core, as determined from a major d-c hysteresis loop, is considered unity. The curve of flux change ratio indicates the rapid reduction in flux change when a core is cycled around a minor hysteresis loop. An increase of approximately 5% in flux change is observed for values of magnetizing force that are two to three times the value of the d-c coercive force.

Fig. 7 pertains specifically to ⅛-mil 4-79 Permalloy, but similar relationships also hold true for the other materials. All will show an increase in flux change and decrease in squareness above the saturation point as the applied pulse magnetizing force is increased. These variations are largely due to the non-zero slopes the region of saturation.

Fig. 8 is a linear graph of median



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Ferromagnetic Cores

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switching time plotted against applied pulse magnetizing force. The three uppermost curves show the switching characteristics for the 48% Ni-Fe materials of 1-mil, ½-mil, and ¼-mil tape thickness while the three lower curves pertain to the 479 Permalloy materials. The 48% Ni-Fe materials require applied magnetizing forces three to five times greater than the 4-79 Permalloy materials in order to achieve a given switching time. The final choice of material, however, depends on the application. The 48% Ni-Fe is suited for applications requiring relatively slow switching, high flux and high power transfer capabilities. The 479 Permalloy materials have been found most useful in the arithmetic and control circuits of low power discrete-data handling systems.

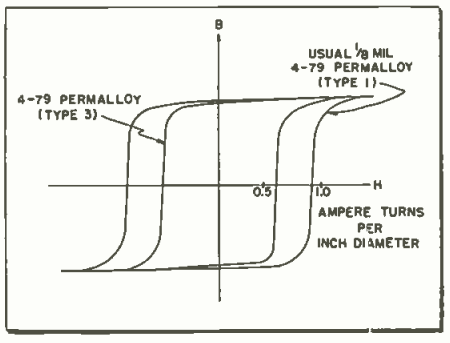

Fig. 11: Median d-c hysteresis loops

Examination of the 479 Permalloy curves shows why the ¼-mil was originally considered better for general computer use than the ⅛-mil. (Type 1). In applications requiring switching times greater than 2 μsecs, the ¼-mil had the advantage of requiring less pulse magnetizing force for a given switching time.

As a result of the BIMAG core development program at the Burroughs Research Center, improved characteristics have been achieved for the ⅛-mill 4-79 Permalloy and are indicated in Fig. 8 as Type 3. The Type 1 and 3 designations were given to distinguish between the commercially available ⅛-mil core and the newly developed ⅛-mil BIMAG core respectively. As indicated by the bottom curve in Fig. 8, the switching time characteristics of the Type 3 ⅛-mil are considerably faster than the Type 1 ⅛-mil and in fact are as fast or faster than the ¼-mil Permalloy for all values of applied field. An equally important advantage of the Type 3 is the considerably greater uniformity in switching time

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Ferromagnetic Cores

(*Continued from page 88*)

characteristic obtained between lots of cores annealed at different times. (This will be discussed in more detail with reference to Fig. 12.)

The curves of Fig. 8 are useful in a comparison of switching time for different materials and for determining the regions in which incremental changes in applied field will have the greater effect. Fig. 9 also shows the median switching time characteristics for the same materials shown in Fig. 8. In Fig. 9, however, the abscissa scale is determined by the reciprocal of switching time. In order to read time directly from

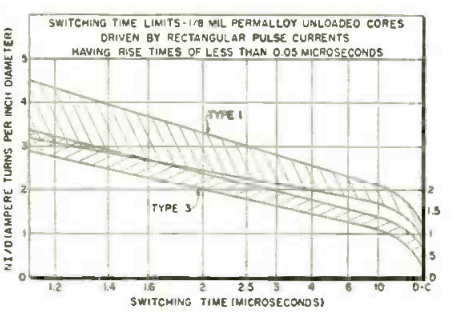
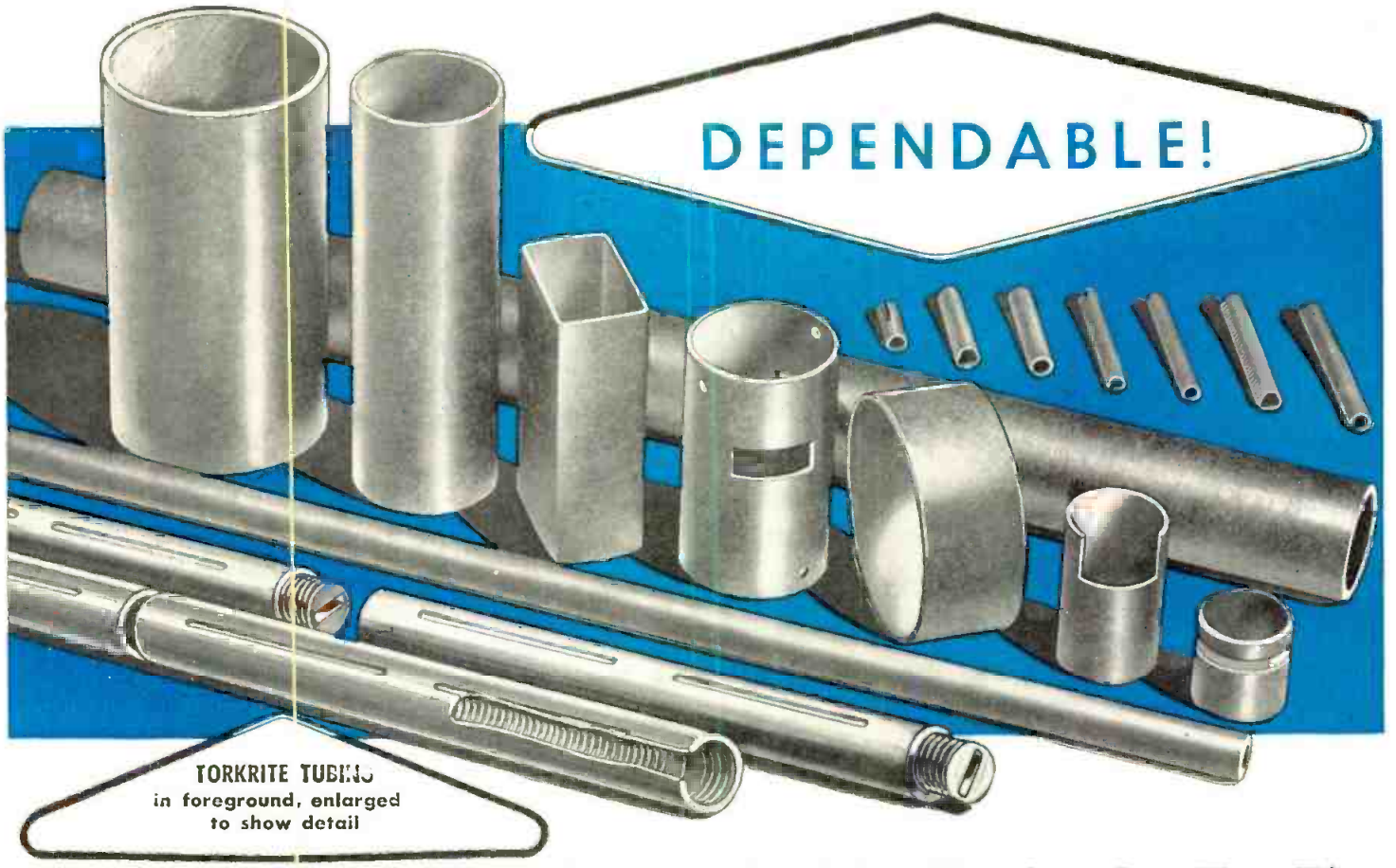


Figure 11

the graph, the scale is calibrated in terms of switching time. The extreme right hand ordinate corresponds to infinite switching time, but for convenience is denoted as d-c, meaning the extremely long switching time associated with an applied magnetizing force just above the value of d-c coercive force. This value of magnetizing force is of interest since it should not be exceeded by noise signals in reliable magnetic core circuits. The switching time curves are now essentially straight lines in the regions of most usefulness and may therefore be defined by straight line equations.

Figs. 8 and 9 pertain to median switching times. For design purposes the engineer should have information indicating the tolerance to be expected for the respective core materials. The solid line curves of Fig. 10 illustrate the upper and lower limits of switching time useful in the design of reliable magnetic core circuits. The dashed curves of Fig. 10 indicate variations that have been observed in the slope of the switching time characteristics of cores obtained from slightly different annealing cycles. The indicated noisy core and slow switching core characteristic curves lie within acceptable limits over a wide range of applied field, but for low values of applied field these cores diverge severely



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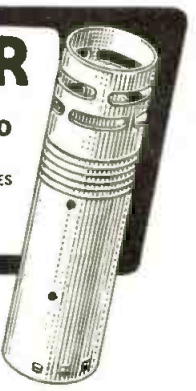

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Ferromagnetic Cores

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from the acceptable limits. For this reason it is advisable to specify and to test magnetic core switching time characteristics at a value of applied field that is sufficiently low enough to detect cores exhibiting these undesirable extremes. Of course, the switching time characteristics should also be checked at two other values of applied field which bracket the expected operating range.

Core Comparison

To indicate the improvement that can be accomplished by concentrated effort on one basic material, a comparison will be made between the d-c coercive force and switching time characteristics of ⅛-mil 4-79 Permalloy as they were about one year ago and what can be achieved at the present time. As a result of the intensive BIMAG development program, annealing cycles were established that could produce ⅛-mil 4-79 Permalloy cores having d-c coercive forces nearly one half the value measured for the usual ⅛-mil 4-79 Permalloy. As indicated in a previous section, the ⅛-mil 4-79 Permalloy cores commercially available during the year 1954 were designated as Type 1. The newly developed BIMAG cores were given the designation of Type 3 and are characterized by considerably faster switching times than the Type 1. It was considered desirable to allow for a Type 2 designation in the event that it proved to be too unreasonable to hold the desired tolerances for the Type 3 cores. After many sample batches of different diameter cores, an annealing cycle was established that could maintain the desired tolerances on the parameters effected by the annealing cycle, namely, the d-c coercive force, squareness ratio and switching time characteristics.

Fig. 11 shows the median d-c hysteresis loops for the Type 1 and Type 3 cores. The variation about the median value of both types is approximately plus or minus 0.25 ampere turns/in. diameter. The shape of the two d-c hysteresis loops are considered average for the two types. Both types exhibit the variations previously indicated in Fig. 6.

Fig. 12 shows the switching time limits established for the Type 1 and Type 3 cores. The limits for the Type 1 cores were established after making measurements on a few thousand cores from commercially available sources. These cores were purchased at various times through-

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Ferromagnetic Cores

(*Continued from page 92*)

out the year 1953 and 1954. The reject rate for various lots of cores obtained during this period was approximately 10% when tested against the Type 1 limits. The Type 3 limits were established after the measurement of a few thousand cores annealed at various times using the annealing cycle established by the BIMAG core development program. The reject rate for the Type 3 core has been approximately 5% on switching time.

The improvement in switching time characteristics is twofold. The switching time variation for a given value of applied field is much narrower for the Type 3 and the value of applied field for a given switching time is considerably lower. For example, at a value of 2 NI/D the switching time for a Type 3 core is 2.5 μsecs plus or minus 20%, whereas the switching time for a Type 1 core is approximately 9 μsecs plus or minus 55... Note also that the median switching time for the Type 3 core is approximately one quarter that of the Type 1 core for the value of 2 NI/D. ■ ■ ■

REFERENCES

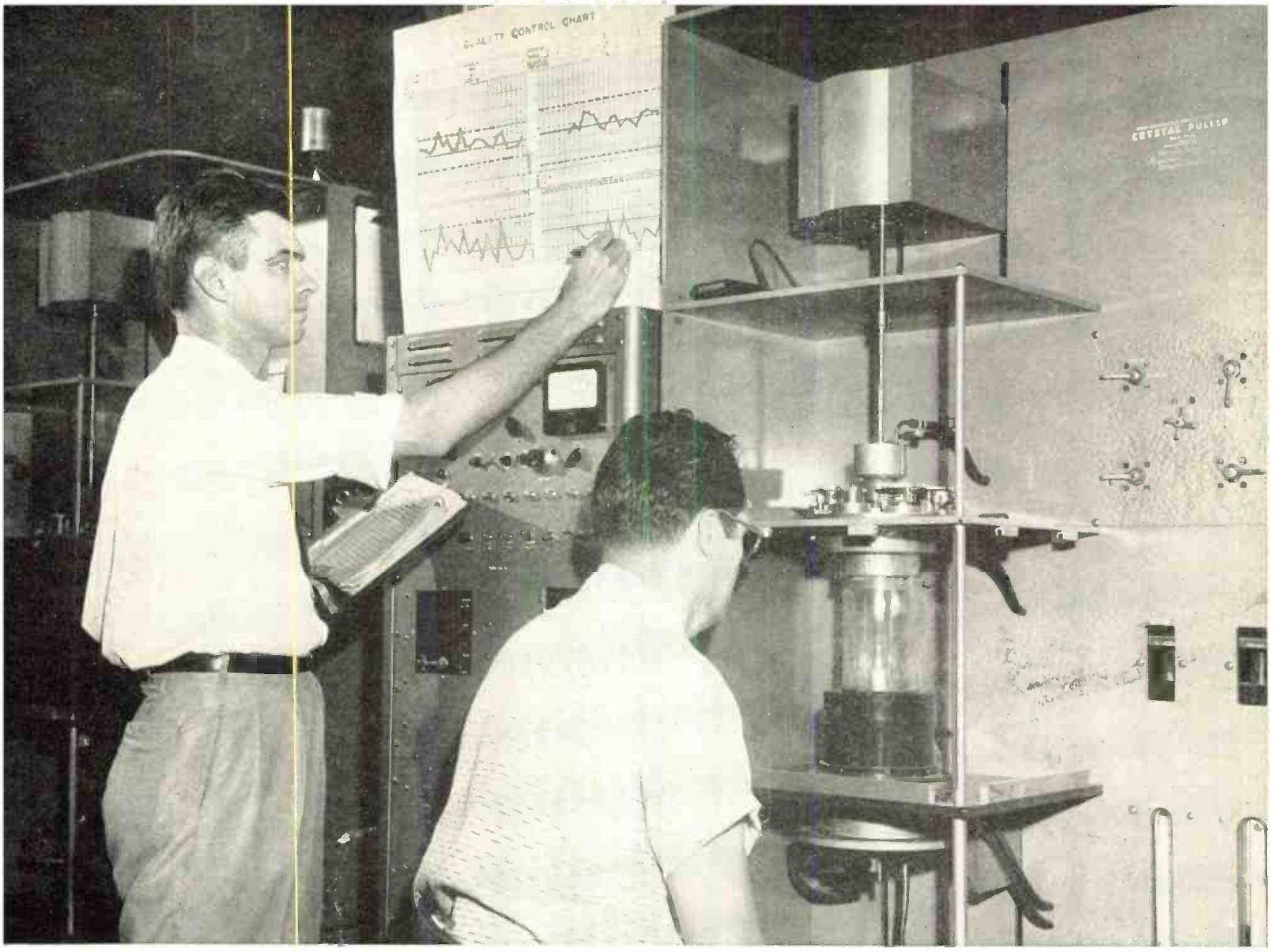
1. Joseph Wylen "Pulse Response Characteristics of Rectangular Hysteresis Loop Ferromagnetic Materials," *Trans. A.I.E.E.*, Vol. 72, pt. 1, pp. 648-656, 1953.

Radar Monitor

(*Continued from page 65*)

controlled by P4, and terminates at the end of the second multivibrator cycle, controlled by P6. As will be described, radar echoes occurring in the duration period of this pulse are fed to the alarm circuit. At all other times, this voltage cuts off the gate tube and prevents echoes from reaching the alarm circuit. Note that if S51 is in the off position, the plate of V8 is always at its lower voltage, and the output of P9 is at its negative value at all times except during the first multivibrator cycle. Consequently, all radar echoes except those occurring during this initial period are fed to the alarm circuit when S51 is in off position.

The video (or echo) signal obtained from the radar set is applied to the grid of phase splitter V11, ½ of a 12AU7, which has load resistors in both the plate and cathode circuits. This stage is inserted in the equipment so that the monitor can accept either positive or negative video signals. If the video signal is positive, S112 is placed in the posi-



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Radar Monitor

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tive position and the output is obtained from the cathode of V11. If the video signal is negative, the output is obtained from the plate of V11. In either case a positive output signal is obtained. The level of this signal is adjusted by video level potentiometer P12 to the proper value for this equipment.

The video signal is amplified by V12 and fed to the diode pickoff, or clipper, circuit. This circuit consists of V13 and V14, both halves of a 12AU7 dual triode connected as diodes (with grids tied to plates). The purpose of this circuit is to cut

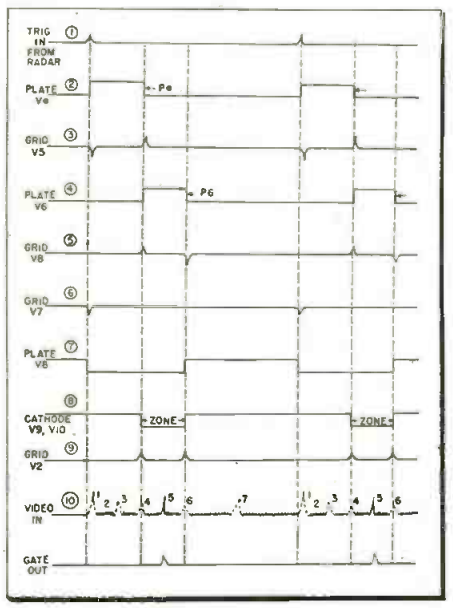

Fig. 3: Timing diagram of radar monitor

off all signals whose amplitudes are equal or below the noise of "grass" level. Thus only signals whose amplitudes exceed the noise level are fed to the gate circuit. The pickoff level is adjusted at the noise level by potentiometer P14 with the aid of the visual indicator V19, as will be described later.

Video signals appearing during the zone period are amplified by gate tube, V15, whose cathode is biased by the voltage obtained at the output of P9. As indicated earlier, this potentiometer is adjusted so that the tube is cut off at all times except during the zone period. When switch S3 is on, a signal corresponding to the main transmitter bank is applied to the plate of this tube. Because of the high amplitude of this signal, it could get through the gate tube which is designed to cut off signals at reasonable levels. However, by applying a positive pulse to the plate of V15 at the same time the video pulse is applied to its grid, the grid signal is nullified and

does not pass through. For the same reason, neither do the range ring pulses (described below) get through the gate. As a result, only the pulse corresponding to an echo occurring in the zone being monitored (pulse 5 in waveform 10, Fig. 3) appears at the gate output. All other pulses, such as the main bang (1), noise (2), other echoes (3), range rings (4 and 6), do not get through this tube.

The output of the gate tube is amplified by V16 and fed to the alarm tube V20. In the absence of a video signal, this tube, a 2D21 thyratron, is cut off. However, the presence of a video signal raises its grid voltage above cutoff and allows the tube to conduct. This energizes an alarm relay which can operate a buzzer and a lamp.

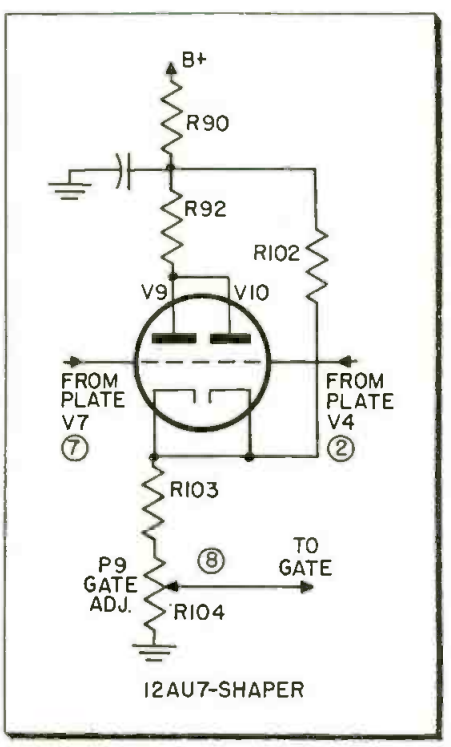

Fig. 4: Stages V9 and V10 comprise shaper ckt

For the convenience of the operator, the monitor produces video signals which create rings on the radar scope corresponding to the zone being monitored. A differentiator-rectifier circuit, CD20 and CD21, detects pulses corresponding to the beginning and end of the zone period (see waveform 9) and applies them through intensity control, P2, to the ring phase splitter, V2. This stage operates similarly to V11 providing either a positive or negative output to the radar set. The pulses are then applied to the video output jack of the radar set and appear on the indicator as range rings.

This equipment also contains a self-monitoring and radar-monitor circuitry which operates an alarm buzzer if either the radar or the Raytector itself fails. ■ ■ ■

MISSILE SYSTEMS

Research and Development

Broad interests and exceptional abilities are required of scientists participating in the technology of guided missiles. Physicists and engineers at Lockheed Missile Systems Division are pursuing advanced work in virtually every scientific field.

▪ ▪ ▪

Below: Missile Systems scientists and engineers discuss future scientific exploration on an advanced systems concept with Vice President and General Manager Elwood R. Quesada. From left to right: Dr. Eric Durand, nuclear physicist, systems research laboratory; Ralph H. Miner (standing), staff division engineer; Dr. Montgomery H. Johnson, director, nuclear research laboratory; Elwood R. Quesada; Dr. Louis N. Ridenour (standing), director, program development; Willis M. Hawkins (standing), chief engineer; Dr. Joseph V. Charyk (standing), director, physics and chemistry research laboratory; Dr. Ernst H. Krause, director, research laboratories.

▪ ▪ ▪

Scientific advances are creating new areas of interest for those capable of significant contribution to the technology of guided missiles.

Lockheed **MISSILE SYSTEMS DIVISION**

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • **VAN NUYS, CALIF.**

D-Amplifier

(*Continued from page 67*)

for half-coil inductance L, the output voltage will be in phase with the input voltage in accordance with the relation

$$V_2 = \frac{1/j\omega C}{1/j\omega C + j\omega L} V_1 = \frac{1}{1 - \omega^2 LC} V_1, \quad (18)$$

where $\omega^2 LC < 1$ for all practical consideration (actually, C does not resonate with the full value L). This is the same polarity of the output

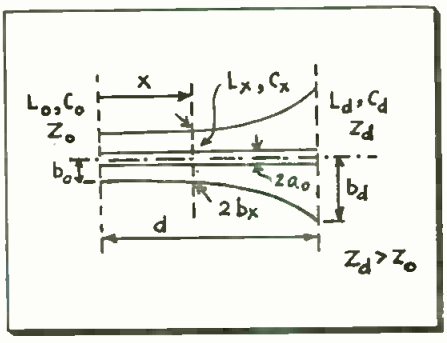

Fig. 7: Tapered concentric line, used as stage couple in D-amplifier systems.

voltage as the magnetic coupling yields, when "reinstated." Accordingly both the electric and the magnetic fields aid in producing a desired output voltage over a wide frequency band. The more uniform the fields are, due to the absence of lumped LC units, the more relieved is the transformer from parasitic resonances. Such parasitic resonances may cause "holes" in the frequency spectrum, and, by conventional consideration, the frequency coverage of the transformer only extends to the first "hole."

By the use of overlapping modes the traveling wave transformer can be made to operate satisfactorily to 500 MC, and with the use of loss-controlled modes, and other "tricks of the trade," the operation can be extended to 1000 MC. The limiting frequency is to a great extent controlled by skin-effect losses. The traveling-wave transformer is just beginning to become appreciated by the designers of commercial D-amplifiers, and one must not overlook its great potentialities in the field.

The Tapered Line is either a lumped transmission line with insignificantly small steps, or a smooth line; in many cases a concentric line. (Since such a line with open slots along its length satisfies the basic theory, the "flat" line design may be used, permitting more natural end-terminations and efficient

D-Amplifier

(*Continued from page 99*)

cooling.) The inductance and capacitance per unit length vary as a function of the length-coordinate, thus providing the desired different input and output impedances of the matching line section. Three major types of tapered lines are used; the easily constructed linearly tapered line, the Gaussian line, and the exponential line.[12,17] The last one, providing a semi-high-pass filter, has been given most consideration in technical text; see Fig. 7. The term "exponential" refers to the fact that the spacing between the line conductors varies in such a fashion that the inductance L_x and capacitance C_x per unit length, vary exponentially with the length coordinate x, thus

$$\left.\begin{aligned} L_x &= L_o\,\epsilon^{kx} \\ C_x &= C_o\,\epsilon^{-kx} \end{aligned}\right\} \qquad \left.\begin{aligned} L_d &= L_o\,\epsilon^{kd} \\ C_d &= C_o\,\epsilon^{-kd} \end{aligned}\right\} \qquad (19),\ (20)$$

Here k is the Flare Coefficient. The inner or outer diameter, or both diameters, may vary, but in the concentric arrangement in Fig. 7 the inner diameter is kept constant at the value $2a_o$. A negative value of k represents $Z_o > Z_d$; the natural application for a higher impedance plate line coupled to a lower impedance, consecutive grid line. The characteristic impedance varies along the transmission line in accordance with the formula

$$Z_x = \sqrt{\frac{L_x}{C_x}} = \sqrt{\frac{L_o}{C_o}}\,\epsilon^{kx} = Z_o\,\epsilon^{kx}, \qquad (21)$$

from which

$$k = (\ln Z_d/Z_o)/d. \qquad (22)$$

Thus the flare coefficient k may be defined as the ratio of the impedances to be matched, in logarithmic measure, per unit length of exponential line. In the basic case the time delay t_d per unit length is constant,

$$t_d = \sqrt{L_x C_x} = \sqrt{L_o C_o}. \qquad (23)$$

A longer line of higher flare coefficient gives an increased impedance transformation ratio, but both d and k have definite limitations. A large change in the transverse dimensions is required for a substantial change in impedance ratio, and a large k-value generally conflicts with good low-frequency response. Inserted dielectric shortens the length of the line, but requires different transverse dimensions, and generally increases the time delay.

More detailed formulas, involving the diameters of the conductors, are derived from equations for Z_x,

L_x, and C_x, yielding the design formula

$$\frac{b_x}{a_x} = \left(\frac{b_o}{a_o}\right)^{\epsilon^{kx}}, \qquad (24)$$

where $a_x = a_o$. One interesting phase of the development of tapered lines involves the use of helical conductors; for example the inner conductor wound in form of a spiral.[17] Here both the pitch and the diameter can be varied, thus both L_x and C_x be controlled; a simultaneous jump in both not affecting Z_x. Generally, adding shaped dielectric of controlled losses, ingenious matching sections of reduced length can be designed; too abrupt "flaring" limiting the low-frequency response, and too abrupt "lumping" via introduced discontinuities limiting the high-frequency response. Still further improvements are possible by matching networks, added outside of the tapered line.

There exists also another type of matching line, the stepped line, which has just a few transitions, not a large number of insignificantly small steps. While this line has been developed above 1000 MC, rather than below 1000 MC, extension of the principle to lower frequencies is possible. An optimum-stepped line transformer is superior to the conventional binomial transformer. The steps are designed to yield an equal-ripple, or Tchebycheff type of response in terms of the reflection coefficient.[20]

The transmission line tube is on one side the most promising development in the D-amplifier field, on the other side the most discouraging one, due to the difficult problems encountered in distributing otherwise lumped electrodes. Already in Percival's original design, the disadvantage of cathode inductance was eliminated, since the cathode also was distributed. The grid and plate lines were uniform, concentric helices, with the cylindrical cathode in the center. The electrons moved radially through the grid to the plate. One of the difficulties encountered was interaction between the helices. More recent designs are discussed below.

Adler's Tube[21] is about the closest one to a successful commercial product that has appeared; it operates from 100 to 1,000 MC with good noise figure, at least 20 db gain, and modest supply voltages; it differs considerably from Percival's idea, and utilizes a magnetic field, which bends the electron trajectories in such a manner that transit time effects are wiped out. This tube will

D-Amplifier

(*Continued from page* 101)

not be discussed further, since it may be classified as a traveling-wave tube rather than a transmission Q-line tube.

The Lewis Tube[22] is based on Percival's idea, but in a realistic fashion Lewis starts out with the concept of inductive and capacitive coupling between the helices. Introducing a mutual shunt conductance between the helices, and individual distributed helix-to-ground conductances per unit length, Lewis derives equations for waves traveling with different velocities in both directions; one "fast mode" and one "slow mode." In the fast mode the grid and plate voltages are in phase; in the slow mode they are 180° out of phase. Lewis points out that the associated characteristic impedances may reduce to one common, resistive, characteristic impedance, if the helices are wound in opposite directions with equal coefficients of inductive and capacitive coupling. If so, the tube may be satisfactorily matched into a system. The Lewis tube provides a push-pull output, and bilateral amplification; like certain transistor circuits it amplifies signals in both directions simultaneously.

The Fowler Tube[23] is similar to the Lewis tube, both tubes representing original contributions to the art. Fowler's investigations, like Lewis', indicates the strong and weak points of helix type tubes, in which grid, screen grid, and plate spiral around a stretched cathode, thus forming a highly complex transmission line system. It is found that the circuit coupling between helices is not always harmful and may be utilized to yield a positive feedback action, thus extra gain. Fowler refers to this action as "transmission-line build-up" and points out one serious effect of mode operation; isolated intervals of good frequency response, separated by low gain, or attenuation, openings. This situation is contradictory to the requirements on extensive frequency coverage and it should be noted that this effect obtains in spite of the fact that the helix proper is a wide band device. Fowler's more recent work includes "modulated helices," "squirrel-cage folded transmission lines," and other innovation, which may greatly advance the art of transmission line tubes.

This paper may be considered to survey the present status of the D-amplifier art. Better tubes and syn-

Conclusions

thesis-derived networks will improve the conventional D-amplifier stage. Modern wide-band couplers will make possible the extension of good stage design to good system design; with many stages in cascade. As far as tube designs go, the ultimate answer to the distributed amplifier problem is provided by proper combinations of transmission-line tubes and suitable wide-band couplers. ■ ■ ■

NOTE with regards to Eq. (14), Part 2. The coefficients k_1 and k_2 were not defined in the text. They are $k_1 = j\omega K_1$ and $k_2 = j\omega K_2$. The reason for the non-real constants is that, inserting $s = j\omega$ in eq. (10), we are not any longer concerned with the 1/s transformation, symbolizing the transient-restricted step-function, but deal with an applied phasor, or sinor, which, being periodic, is represented in the s-domain by a unit transform.

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Direction Finder

(Continued from page 62)

at any one time, connected to a common output through an equal number of phasing or delay lines. The phasing lines were to be of such lengths that the total effective transmission path length from the source to output would be the same for each active antenna element. In order to minimize the amplitude of side lobes in the antenna pattern, the illumination of the aperture was to be tapered by placing attenuators

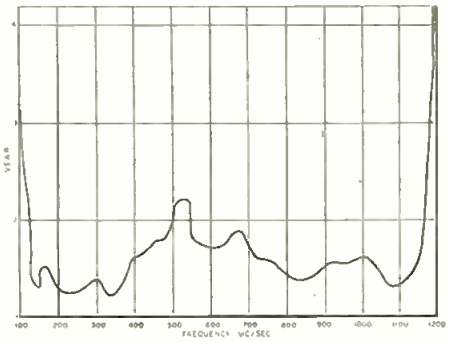

Fig. 9: VSWR at various frequencies

in several of the active leads.

Calculations of the lengths of the delay lines appeared to be a formidable task if all the cross-coupling effects among the antennas were taken into account. For this reason, the simplest possible approach was used; that is, simple geometrical calculations. It was felt that this might possibly offer a satisfactory solution and that if it did not, it would be a relatively simple matter to replace the lines with another set based on other calculations. This initial assumption proved to be valid and no modification to the original calculations was necessary.

The stationary antenna array was made up of 100 vertically polarized dipoles mounted in front of a cylindrical reflector at the top of a 50 ft. tower. A standard "military" dipole which showed a VSWR of 2 or less over the frequency band was employed and, although it was not designed for the specific purpose at hand, proved to be entirely adequate. Fig. 7 shows a portion of the assembled array. The antennas were connected to the r-f switch by lengths of coaxial cable, carefully cut so their electrical lengths were uniform within 2° to insure a uniform pattern.

The r-f switch itself can be further divided into several functions: the commutating device, the delay lines, the coupler, rotary joint and mechanical drive. The input to the commutator is 100 r-f leads and the output 36 leads which feed the de-

lay lines. The requirements of long life, low noise and high speed led to the immediate discarding of any method utilizing mechanical contacts. Non-contacting switching devices of the capacitive type had been used in the past and some work had been done along this line at the Cambridge Air Force Research Center but their application to the problem appeared marginal. The first model tried was of the capacitive type and it was found that if sufficient coupling capacity was provided at the lowest frequency, the structure would be impractical from a mechanical point of view. The next step was to modify the coupling plates so that they became quarter-wavelength transformers, a configuration familiar in coaxial rotary joints. Instead of rotary motion, however, linear motion was to be used, and the line was made of flat strips to permit it. Because the center conductor was not a thin strip but several strips with air gaps, the usual impedance formulae did not apply and a set of design formulae for the special case had to be established from experimental work. The resulting commutator element was not as broad band as desired so the design was further modified by the addition of another quarter-wave section. Two line segments were used and their parameters optimized by formulae found in literature. Fig. 8 shows the original and modified elements. The stator portion is on the left and the rotor on the right. Z_1 is a high impedance and Z_2 a low impedance compared to the basic line impedance Z_o, which is 50 ohms. Measured results of the modification showed a definite improvement; the VSWR is shown in Fig. 9 over an extended frequency band. Operation should be possible up to about 1100 MC, except perhaps for the region around 700 MC.

Up to this time, a flat radial configuration had been considered for the commutator, with 100 input connectors around the periphery, but further study indicated that a cylindrical arrangement would have definite mechanical advantages. For this arrangement, the stator was to be two cylinders of plastic with line segments painted on adjacent surfaces and the rotor another cylinder coaxially positioned between these two.

There were several mechanical problems to be solved in utilizing the cylindrical arrangement. Since the diameter of the cylinders was about 12 in., the strains resulting from rotational and temperature effects were of greatest importance.

Direction Finder

(*Continued from page* 105)

Calculations indicated that operation at 1800 rpm should be safe insofar as these effects were concerned but there was some question whether the delay cables could be adequately restrained under the expected condition of 500 G acceleration. A model of the rotor, tested at speeds in excess of 1800 rpm without delay lines, showed no failure. Nevertheless, it was decided to limit the speed to 600 rpm.

The coupler has the function of connecting 36 active lines together and feeding a single 50 ohm cable. Since the input is effectively at an impedance level of about 1.5 ohms, the device is essentially a broad band transformer. A series of quarter-wave coaxial lines were used, their impedances stepped according to the binomial coefficients. To shorten the length of the structure, the sections were telescoped into each other and the total length limited to ¼ λ.

Connecting the commutator and the coupler are the delay lines which provide the necessary delay to the signals received by the various antenna elements so they all arrive at the output in phase. Attenuators were used in some of the lines to provide a tapered illumination of the aperture for the purpose of reducing

Fig. 10: Completed rotor assembly

side lobes and the electrical lengths of these were accounted for as part of the delay. Since no quantitative data were available which offered any help in determining the tolerances to which the lines should be cut, they were held within 2° of the computed values. Variations here would effect pattern shape. Fig. 10

shows the completed rotor assembly ready to be installed in the aluminum casting which housed it and served as a mount for the drive motor.

The initial trials were carried out with a set of delay lines of a zoned design; that is, integral wavelengths

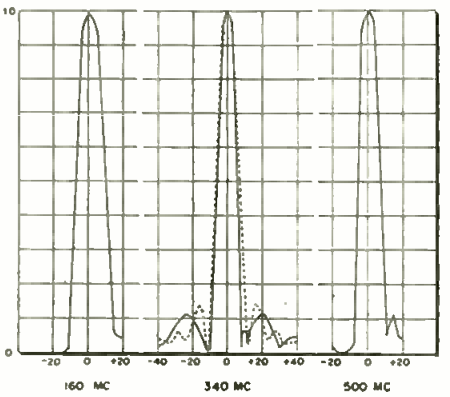

Fig. 11: Measured and predicted patterns

were subtracted from the longer lines; a step taken to reduce the total rotating mass in the switch. This was found to result in good operation from 270 to 390 MC but the pattern became poor beyond these limits. After the lines were re-cut to their full length and reinstalled, the pattern was found to vary only slightly from 225 to 400 MC and at the design center frequency was about 6° in width. Fig. 11 shows a comparison between the measured pattern and the pattern predicted from calculations made at the Harvard Computer Lab. from data supplied by Syracuse Univ. The principal difference is in the symmetry of the side lobes. This probably results from tolerances throughout the system. Other patterns, measured at 160 and 500 M3 are also sown in this figure. Between these limits, the pattern changed very slightly.

Measurements of the bearing accuracy were made with the aid of surveying instruments, using a target transmitter about 500 ft. from the tower. Bearings displayed on the CRT could be determined to within about 0.25° by careful reading and this source of error may account for the small variations in the system error curve shown in Fig. 12. The only adjustment made on the direction finder was to orient the zero position of the indicator to true north. Repeated measurements proved that bearings could be determined to ±1° and there is a good possibility that a correction curve can be used to achieve even greater accuracies.

The antenna gain was measured by comparing the output of the ar-

Direction Finder

(*Continued from page* 107)

ray with the output of a dipole located immediately above the array: this showed a 14 db gain at 340 MC. This is a little less than might be expected from examination of the pattern and may be partly due to the impedance match of the system. The VSWR was measured looking into the output of the r-f switch and was between 1.2 and 2 in the design pass band, rising to 4 at 450 MC and to 8 at 500 MC. Even with the large mis-match at the highest frequency, the pattern was satisfactory.

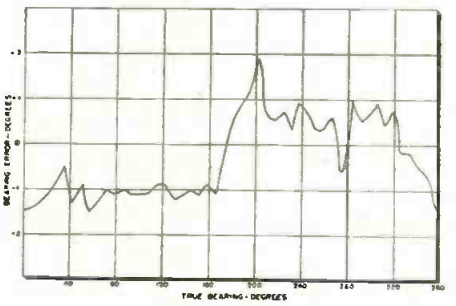

Fig. 12: Variation from true bearing

Since the pattern and gain were both usable despite the relatively poor impedance match obtained outside the design pass band, the question arises as to what factors limit the frequency coverage which may ultimately be realized. The antenna elements themselves were designed for operation over a limited frequency range and appear to be one factor. The spacing between antennas, approaching a full wavelength at 800 MC, may be another. However, the theoretical finding was not confirmed by operation at 500 MC and 0.6 wave spacing. At this time, the limits of system operation have not been found but a bandwidth greater than 3 to 1 has been measured.

Another effect which was predicted but not proved in practice was cogging of the pattern. That is, since the commutator elements are discretely spaced at 3.6 degree intervals, it was anticipated that there would be discontinuities in the pattern at these intervals. Such an effect might have been present had the commutator used mechanical switching but with the arrangement employed, the making and breaking of contract was a gradual process. When the target transmitter was moved continuously, the indicator pattern also moved continuously, changing only slightly in beamwidth. ■ ■ ■

Current Supplies

(*Continued from page 66*)

used to better than 1% by adjusting its zero set screw for accuracy at this one point. A front panel adjustment (cal) is included in the comparator circuit to permit vernier adjustment of E_s to the calibration point. Thus small output changes due to inadequate regulation or drift in the V.R. tube may be eliminated by adjusting the calibration control for a red-line indication on the meter. Moreover, the meter provides an almost foolproof indication of correct operation of the entire circuit.

Since

$$I = \frac{E_s}{R_s} = E_s G_s \left(G_s = \frac{1}{R_s} \right)$$

decade switching of I can be realized by decade switching of G_s, that is, by switching resistors in parallel. Only four resistors per decade are necessary, as is well known in the parallel switching of condenser decades. The problem is to represent the digits 1 through 9 (or possibly 10, if overlapping decades are desired) by the sum of one or more of four elements. The various systems of switching follow from the numerous possible choices of the four elements. For example: the 1234 system, the 1235, 1236, 1247, 1248, 1136, and etc. While the 1234 system is generally used in condenser decades, we consider two

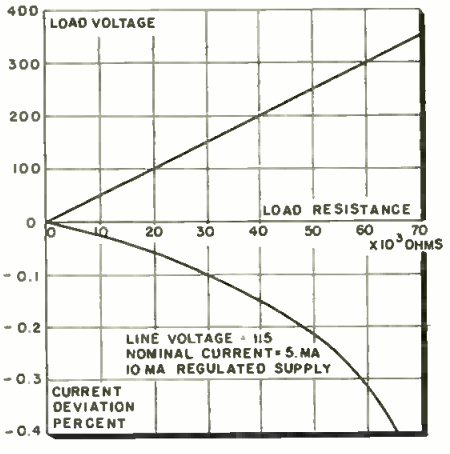

Fig. 4: Regulation (%) vs. load resistance

other systems to be preferable. These are the 1236 and 1225 systems. The 1236 system has the advantage of simple switching, since no more than two resistors need be paralleled to go from 1 to 9 (the 1247 system is the only other one with this property—it should be noted that no system will go to 10 without paralleling three resistors at some position), while the 1225 system uses stock sizes of precision components. For this reason, the 1225 system was adopted for laboratory use. Fig. 2

Current Supplies

(*Continued from page 109*)

shows the switching required for a single decade, using ordinary selector switch wafers. In a production design special switches and components could be used, and other considerations might control the choice of "code," as it is called in connection with digital computers.

Fig. 3 shows a small regulated supply designed for the range 0-10 ma. Since a negative supply is necessary in any case to cut off the series tube,

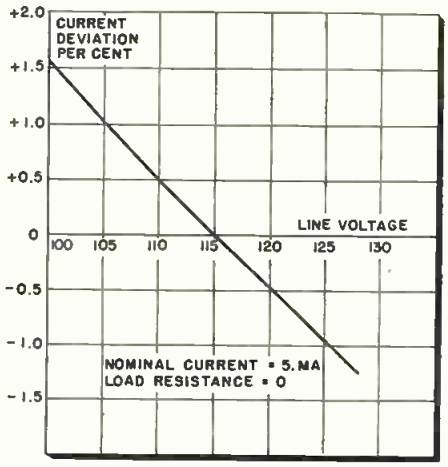

Fig. 5: Regulation (%) vs. line voltage

and is a great convenience in the design of the dc coupled voltage amplifier, a negative reference voltage is used, and is mixed with the positive E_g to produce approximately zero into V4A. The resistive divider is driven by a cathode follower (V4B) on the signal side to avoid shunting the decades by the mixer. The 100k cathode resistor of V4B serves both as one leg of the mixer and as the dc path for V4B. While the comparison circuit (mixer) does not shunt the decades, the voltmeter does. Therefore, a meter current of 0.1 ma was selected (using center scale on a 200 μa meter), and the 0.1 ma decade was numbered 0.1 to 1.0 instead of 0 to 0.9. A VTVM would eliminate this inconvenience (for example, the plate current of V4B is an accurate indication of E_g if the 100k cathode resistor is stable), but would introduce some additional inaccuracy and uncertainty. V8 is present for meter protection during warmup and switching—normally it is non-conducting. Together with the use of the meter at half-scale, it prevents needle banging and insures long meter life and accuracy. Figs. 4 and 5 show the regulation of this supply against load resistance and line voltage. The latter is not outstanding (±0.5% stability for line voltage between 110 and 120 v),

News of MANUFACTURERS' REPS

Emory Design and Equipment Co., 404 Dexter Ave., Birmingham, Ala., has been appointed manufacturer's rep to provide engineering service for **Robinson Aviation, Inc.**, Teterboro, N.J., in the states of Alabama, Florida, Georgia, and Tenn.

Computing Devices of Canada, Ltd., 311 Richmond Rd., Ottawa 4, Ontario, has been appointed exclusive Canadian agent for **Texas Instruments, Inc.**, 6000 Lemmon Ave., Dallas, Texas, manufacturers of all types of transistors.

Ransom Research, San Pedro, Calif., has appointed two new reps. **Hugh W. Parsons** Associates, 31 Somerset Place, Clifton, N.J., will rep for them in the Metropolitan New York and Northern New Jersey area, and **King-Moon Co.**, 15127 Ventura Blvd. (P.O. Box 1245) Sherman Oaks, Calif., will handle the sales coverage in Southern Calif. and Arizona.

J. E. Hachten Co., San Gabriel, Calif., has been named west coast representative for **Condenser Products Co.**, division of **New Haven Clock & Watch Co.**, New Haven, Conn.

Instruments for Industry, Inc., 150 Glen Cove Rd., Mineola, N.Y., has made two new rep appointments recently. **Edward Hoffman**, 1641 Schaeffer Ave., St. Paul, Minn., will handle their line of amplifiers in the North Central section of the country. **John J. Goode Associates**, 211 Eliot St., Ashland, Mass., has been designated their New England representative.

The G. S. Marshall Co., 40 So. Robles Ave., Pasadena, Calif., manufacturer's reps, on the west coast, have added two new men to the Instrument Division engineering sales staff at the main office in Pasadena. **Hale Faris**, a graduate of the Illinois Institute of Technology, has had 13 years experience in the electronics field with such companies as Eicor, Redmond Company, and Motordyne, Inc. **Gerry Friederici**, is an engineering graduate of the Univ. of Minnesota and has been associated for the past 8 years with such companies as the B. F. Goodrich Co., Delron Co., Inc., and Century Engineers, Inc.

M. E. Bourns, president of Bourns Laboratories, Riverside, Calif., manufacturer of precision potentiometer instruments, has appointed **Brierley, Davis Co.**, 332 Springfield Ave., Summit, N.J., as exclusive field engineering rep for their instrument division. The territory includes all states east of the Mississippi River, plus Minneapolis, St. Paul and St. Louis.

Howard Golenpaul has joined **Simberkoff Sales Co.**, Hoboken, N.J., manufacturers reps specializing in radio-electronic parts and equipment. This move will enable him to apply his technical training and experience to sales engineering. Howard is the son of Charley Golenpaul, who heads up distributor sales for Aerovox.

Howard B. Saltzman, sales manager of Alpha Wire Corp., 430 Broadway, N.Y., has announced the appointment of the **Leonard L. Minthorne Co.**, 7521 N.E. Glisan Ave., Portland, Ore., as their rep for the territory of Washington, Oregon and Western Idaho.

Saffro & Gettleman Co., Manufacturer's Representatives at 227 W. Chicago Ave., Chicago, Ill., have recently added a mobile trailer to their facilities to be used to show and demonstrate various pieces of equipment to their customers.

Tronic Engineering Associates, 11 So. Austin Blvd., Chicago, Ill., and **Rex Electronics**, 1351 East De Loss St., Indianapolis, Ind., have been appointed as representatives to handle the line of magnetic shielding products manufactured by the **Magnetic Shield Div.** of the **Perfection Mica Co.**, Chicago, Ill.

The J. Y. Schoonmaker Co. of Dallas, Texas, has been appointed to represent the **Narda Corp.**, manufacturers of microwave and UHF test equipment, in Texas, Oklahoma, Arkansas, and Louisiana.

Standard Electronics Corp., 285 Emmet St., Newark, N.J., implementing its dynamic expansion program, has appointed the Commercial Electronics Corp., 1027 Levee St., Dallas, Texas, as its Southwestern Engineering Sales Representative, to handle their line of TV transmitters and associated equipment.

The Improved Seamless Wire Co., Providence, R. I., announced the appointment of Henry C. Griffin as its midwestern representative. His business address is Box 328, Wheaton, Ill.

Baird Associates, Inc., Cambridge, Mass., has appointed the following representatives who will take over the firm's transistorized products: G. B. Miller Co., 1550 N. Highland Ave., Hollywood, Calif. Technical Instruments, Inc., 971 Main St., Waltham 54, Mass. S. S. Lee Associates, 3433 Connecticut Ave., N. W. Washington 8, D.C. G. G. Leeds Co., Crampton Lane, Great Neck, N.Y. Hugh Marsland & Co., 6405 No. California Ave., Chicago 45, Ill. R. K. Burtner, P.O. Box 529, Far Hills Branch, Dayton 9, O. Measurement Engineering Ltd., Arnprior, Canada. Ad Auriema, Inc., 89 Broad St., New York 4, N.Y.

Fuel Measurement

(*Continued from page 55*)

duction in size, weight and power consumption to where the combination of functions are practical and reliable. This gives a basic gauge made up of a sensing component (tank units) and an indicating component. This indicating component contains all of the gauge functions not included in the tank units such as amplifier, high and low level switches, indicator motor, gear train, potentiometers and indicating dial. The resulting savings are approximately as follows:

68% reduction in weight
70% reduction in power
88% reduction in volume

The combined unit (Fig. 1) is hermetically sealed. The reliability resulting from the use of transistors

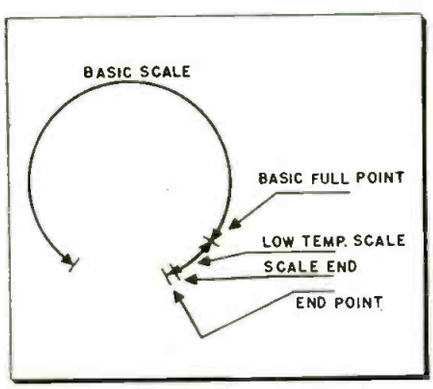

Fig. 5: Dial presentation of fuel quantity

was necessary before amplifying stages could be completely hermetically sealed.

The dial presentation of fuel quantity information involves the basic scale calibration based on 0° C. and a low temperature scale near the full end of the dial. The basic scale calibration is in pounds of fuel and covers most of the dial. The low temperature scale is made up of full points corresponding to a full tank from the end of the basic scale (full at 0° C.) to end of the dial (full at −55° C.). See Fig. 5.

When the system is complicated by several auxiliary functions and/or the available space for the indicator is limited, the amplifier and allied components may be mounted on a chassis as a separate power unit. This arrangement allows more flexibility in making connections and making use of two small spaces instead of one bigger space. When more than one indicator is to be operated from one amplifier, separate power units are necessary. See Fig. 6.

The indicator is designed with space to add the following functions: a. Level switch to signal low fuel

Fuel Measurement

(*Continued from page* 113)

levels. This switch is adjustable through the lower 150° of the indicator dial.

b. High level switch to signal high fuel levels. This switch is adjustable through the upper 150° of the indicator dial.

c. Test switch lead from the indicator or power unit depending upon the selected connections. If this lead is connected and disconnected to ground through a switch, the gage will operate toward the empty position when the switch is on and return to the original position when the switch is off. This test proves that the gage is operating and is capable of accurately returning to the position shown before testing.

d. Auxiliary potentiometer in the indicator gives a separate voltage proportional to fuel quantity.

e. A signal proportional to fuel quantity is available from the rebalancing potentiometer.

Separate auxiliary equipment is available as follows:

a. Equivalent capacitance to be used in making electrical substitutions for tank units that are removed, without affecting the calibration of the gage. An operating condition illustrating this need would be tanks that are removable on the ground.

b. Transfer relays with double pole, double throw contacts, can be used to transfer from one group of tank units to another group of tank units, or from an equivalent capacitance to a group of tank units. A four-pole double throw relay can be used to transfer from one indicator to another where separate power units are used.

The summing of tank unit signals for the tanks being measured by one gauge is accomplished by connecting the tank units in parallel. The fuel is totalized or summed because the gauge indicated the total quantity of fuel.

When two or more gauges are on the airplane, the individual quantities of fuel are indicated by each gauge. The total quantity of fuel aboard can be obtained by summing the individual quantities. The individual signals representing fuel quantity can be obtained from the wiper of the indicator potentiometer or from an auxiliary potentiometer connected to the same shaft.

The totalizing of fuel quantities must be done with a maximum amount of reliability and accuracy. The following points are important:

a. Power failure of any of the indi-

Fuel Measurement

(*Continued from page 114*)

vidual gauges, or loss of signal from any individual gauge, shall only result in no signal coming from that gauge.

b. Malfunctioning of the totalizing systems shall not affect other individual systems.

c. Malfunctioning of individual systems shall not affect other individual systems.

d. The accuracy of the summing system must be as accurate as the individual systems.

Calibration procedure can be a major source of gauge error. The most accurate calibration procedure includes the following principles:

a. The empty calibration is as accurate as the adjustment of the zero setting of the total indicator pointer position.

b. Each quantity of fuel is indicated on the totalizing indicator so that the total quantity indicated is as accurate as the final adjustment of the total indicator pointer position.

c. The calibration between empty and full is as accurate as the linearity of the individual and totalizing indicator potentiometers.

Reliability is very closely associated with accuracy because it is useless to have accuracy that is not available. The gauge must work and keep working if the pilot is to have the required information on fuel quantity and have confidence in that information. The degree of reliability obtained depends upon the quality of installation and the performance of the components of the gauge.

The objective of fuel quantity measurement is to make available to the pilot and/or flight engineer reliable and accurate information regarding the available fuel quantity. The large number of variables involved in a null system would make its use impractical if they all affected accuracy. Such factors as amplification, voltage, and frequency changes can vary through wide limits without affecting accuracy. Tank unit empty capacitance variations can be eliminated by calibrating against the tank unit for the empty calibration.

The accuracy of a capacitance-type fuel gauge installed in an airplane is dependent upon three factors:

1. Installation and calibration tolerances.
2. Fuel and/or fuel temperature variations.
3. Fuel gauge manufacturing tolerances.

Calibration checks provide the only means whereby the over-all ac-

curacy of the fuel gauge installation in the airplane can be determined.

The fuel characteristics absorb a share of the allowed tolerance limit so it is necessary to keep the fuel gauge manufacturing tolerances and the installation and calibration tolerance as small as possible. There are several factors that contribute to the over-all installation and calibration tolerances such as:

1. Tolerances associated with having the airplane in the correct altitude.
2. Tolerances associated with the vertical and lateral placement of the tank.
3. Tolerances caused by stretching of the fuel tank.
4. Tolerances on the fuel tank total volume.

The fuel and/or temperature variations are limited by proper compensation to the extent that the maximum fuel errors are limited to ± 2.0% of full scale at 0° C. The maximum temperature errors are limited to 1.0% of full scale for temperature variations from −55° C. to +55° C.

The manufacturing tolerances are important to the extent that they enter into the determination of the over-all fuel gage error. Manufacturing specifications must keep these tolerances small and stable. ■ ■ ■

Letters

(*Continued from page 22*)

Electronics Conference, that is held the last week of September or the first week of October. We have found that this convention serves our purpose in the midwest to the same degree as the IRE national convention in March in New York City does for the East coast, and WESCON does for the West coast.

Therefore, if you are counting votes, please count ours in the "nay" side.

Dr. Victor Wouk
Chief Engineer

Beta Electric Corp.
New York, New York

Ed. note: Following comparative figures on registrations and number of exhibitors for 1954 functions is of interest;

	Registration	*Exhibits*
IRE National Convention (New York City)	*42,133*	*704*
WESCON (West Coast)	*22,936*	*500*
National Electronics Conference	*7,323*	*158*

Test Equipment

(*Continued from page 57*)

resistance high. As $I_b \rightarrow 0$, the dc input resistance of the transistor rises. The entire 10 μA decrement of step 3 will enter the base only if the input resistance is small compared to the base bias supply resistance.

3. Certain steps must be taken to protect the meter.

a. A fixed resistance of 50 kilohm is inserted in series with P_{2a} and P_{2b}. If the potentiometers are both set to zero, this limits the meter current to 450μA under worst conditions.

b. A 1N91 type junction diode is inserted in series with the meter during steps 1 and 2. If the transistor being measured happened to be shorted from emitter to collector we would have the circuit of Fig. 7. For step three, the diode is removed to keep the meter resistance low.

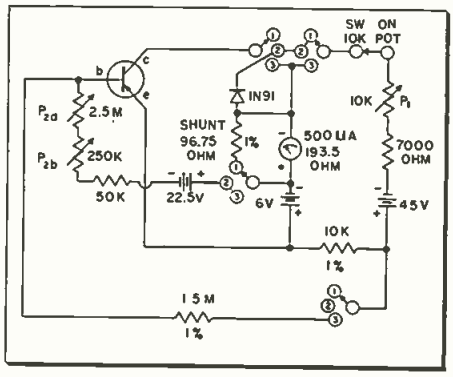

Fig. 8: Ckt of P-N-P transistor tester

The final circuit is shown in Fig. 8. If the instrument were designed for n-p-n transistors, all batteries, meter, and diode would have to be reversed.

A standard meter case was used as it conveniently holds both the meter and the associated circuitry. Concentric potentiometers for P_{2a} and P_{2b} result in some simplification. The operating procedure consists of three steps, and is engraved on the front panel of the instrument as shown. These steps are:

a. Adjust P_1 to 50 with switch in position (1).

b. Adjust P_2 to zero with switch in position (2).

c. Read

$$\frac{\alpha}{1-\alpha}$$

with switch in position (3).

Some error will arise due to the fact that shunting the 10 kilohm precision resistor results in a slight unbalance of the bridge. Consider

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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Test Equipment

(*Continued from page 118*)

the circuit of Fig. 9.

$$I_1 R_1 = E_1$$

$$I_2 (R_2 + R_3) = E_2 - E_1$$

$$(I_2 - I_1) = \frac{E_2 - E_1}{R_2 + R_3} - \frac{E_1}{R_1}$$

$$\frac{d (I_2 - I_1)}{dR_3} = - \frac{(E_2 - E_1)}{(R_2 + R_3)^2}$$

$$\Delta I = \Delta (I_2 - I_1) = - \frac{(E_2 - E_1)}{(R_2 + R_3)^2} \cdot \Delta R_3$$

Since R_3 is changed from 10 kilohms by shunting with 1.5 megohms,

$$\Delta R_3 = - 66.2 \text{ ohms}$$

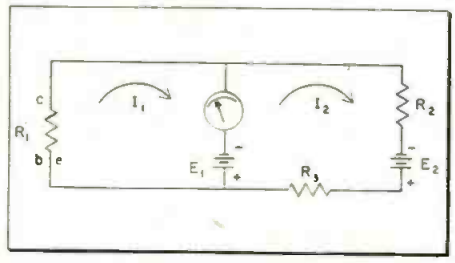

Fig. 9: Shunting the 10 K precision resistor results in a slight unbalance of the bridge

substituting the other numerical values,

$$\Delta I \approx 3.82 \mu A$$

so that the meter will actually read:

$$\frac{\alpha}{1 - \alpha} + .382$$

The error may be either neglected, or used as a correction factor. ■ ■ ■

References

1. R. F. Shea, *"Principles of Transistor Circuits,"* John Wiley and Sons, Inc., New York, N. Y. (1953)

"Graphical Construction Of Reflected Wavefronts"

In this article, which appeared in the June 1955 issue of TELE-TECH and which offered a simplified method of constructing reflected wavefronts graphically without the construction of normals and without the use of angles, the caption text under Figs. 2 and 3 were inadvertently switched and should be interchanged. Also, the word "join" should be inserted before CP under (1) on p. 413.

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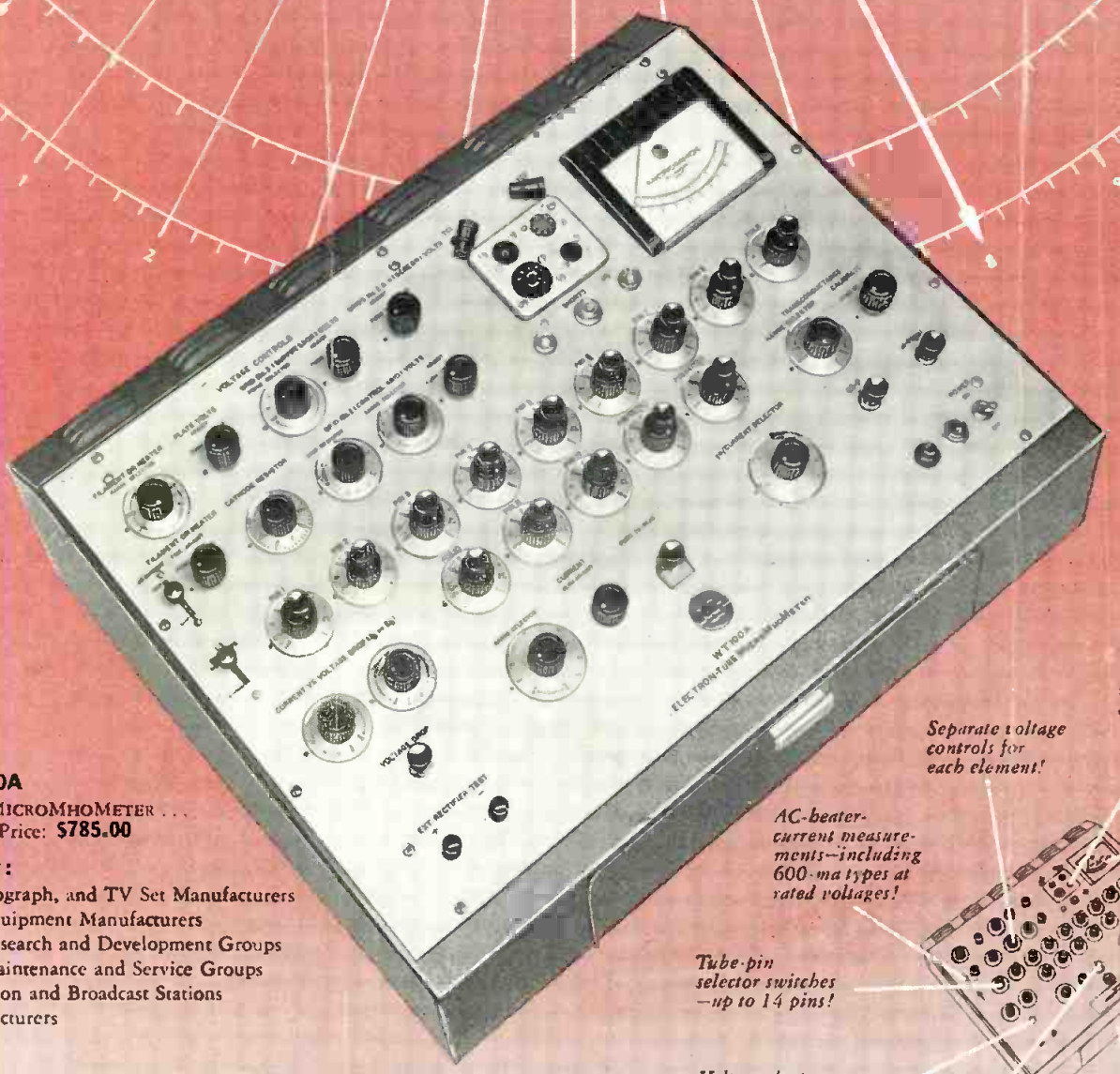

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