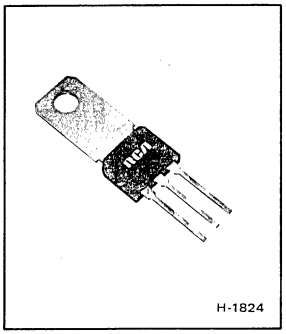
RCA
Solid State
Division

Power Transistors
RCP111, RCP113, RCP115, RCP117 Series



High-Voltage, Medium-Power Silicon N-P-N Power Transistors

For TV Video Output and Linear-Amplifier Applications

V_{CEO} (V) \ h_{FE}	At V_{CE} = 10 V, I_C = 25 mA			
	50-300	30-150	50 min.	20 min.
350	RCP111D	RCP113D	–	–
300	RCP111C	RCP113C	–	–
250	RCP111B	RCP113B	RCP115B	RCP117B
200	RCP111A	RCP113A	–	–
100	–	–	RCP115	RCP117

Note: Characteristics charts for individual device types show h_{FE} measured at additional current levels.

Features:

- **Low Miller feedback capacitance: $C_{b'c}$ = 2.25 pF max.**
- **Thermal-cycling ratings**
- **Maximum safe-area-of-operation curves**
- **High gain-bandwidth product: f_T = 80 MHz typ.**

The RCP111-, RCP113-, RCP115-, and RCP117-series power transistors are double-diffused, epitaxial-collector silicon n-p-n transistors with planar junctions and field-shield construction. These transistors are designed especially for TV applications such as RGB output, chroma output, and video output. They are also suitable for use in regulators, audio output and amplifier circuits, and electrostatic deflection in display circuits. The devices are supplied in a new molded plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCP111D RCP113D	RCP111C RCP113C	RCP111B RCP113B	RCP111A RCP113A	RCP115B RCP117B	RCP115 RCP117	
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:								
With base open	$V_{CEO}(sus)$	350	300	250	200	250	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	7	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	150	150	150	150	150	150	mA
CONTINUOUS BASE CURRENT	I_B	50	50	50	50	50	50	mA
TRANSISTOR DISSIPATION:	P_T							
At case temperatures up to 25°C		6.25	6.25	6.25	6.25	6.25	6.25	W
At ambient temperatures up to 25°C		1.56	1.56	1.56	1.56	1.56	1.56	W
For pulse operation		See Fig. 1						
TEMPERATURE RANGE:								
Storage and Operating (Junction)		–65 to 150						°C
LEAD TEMPERATURE (During Soldering):								
At distance ≥ 1/16 in. (1.39 mm) from case for 10 s max.		230						°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP111D		RCP111C		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	350 300					– –	1 –	– –	– 1	μA
With base open	I_{CEO}		250 200			0 0	– –	5 –	– –	– 5	μA
Emitter Cutoff Current	I_{EBO}			6	0		–	10	–	10	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		50 25	300 –	50 25	300 –	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO}(sus)$				20[a]	0	350	–	300	–	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		–	1	–	1	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		7	–	7	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				25[a]	2.5	–	1	–	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\lvert h_{fe} \rvert$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		100				100	–	100	–	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		–	2.25	–	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						–	20	–	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						–	80	–	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

TERMINAL CONNECTIONS

Terminal No. 1 — Emitter
Terminal No. 2 — Base
Terminal No. 3 — Collector
Terminal No. 4 — Collector

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP111B		RCP111A		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	250 200					— —	1 —	— —	— 1	μA
With base open	I_{CEO}		175 150			0 0	— —	5 —	— —	— 5	μA
Emitter Cutoff Current	I_{EBO}			6	0		—	10	—	10	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		50 25	300 —	50 25	300 —	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO(sus)}$				20[a]	0	250	—	200	—	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		—	1	—	1	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		7	—	7	—	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				25[a]	2.5	—	1	—	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\|h_{fe}\|$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		100				100	—	100	—	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		—	2.25	—	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						—	20	—	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						—	80	—	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO(sus)}$, MUST NOT be measured on a curve tracer.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP113D		RCP113C		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	350 300					– –	1 –	– –	– 1	μA
With base open	I_{CEO}		250 200			0 0	– –	5 –	– –	– 5	μA
Emitter Cutoff Current	I_{EBO}			6	0		–	10	–	10	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		30 15	150 –	30 15	150 –	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO}(sus)$				20[a]	0	350	–	300	–	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		–	1	–	1	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		7	–	7	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				25[a]	2.5	–	1	–	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\|h_{fe}\|$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		100				100	–	100	–	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		–	2.25	–	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						–	20	–	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						–	80	–	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP113B		RCP113A		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	250 200					– –	1 –	– –	– 1	μA
With base open	I_{CEO}		175 150			0 0	– –	5 –	– –	– 5	μA
Emitter Cutoff Current	I_{EBO}			6	0		–	10	–	10	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		30 15	150 –	30 15	150 –	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO(sus)}$				20[a]	0	250	–	200	–	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		–	1	–	1	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		7	–	7	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				25[a]	2.5	–	1	–	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\|h_{fe}\|$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		100				100	–	100	–	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		–	2.25	–	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						–	20	–	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						–	80	–	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO(sus)}$, MUST NOT be measured on a curve tracer.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP115B		RCP115		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	250 100					– –	50 –	– –	– 50	μA
With base open	I_{CEO}		175 70			0 0	– –	100 –	– –	– 100	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		50 10	– –	50 10	– –	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO}(sus)$				20[a]	0	250	–	100	–	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		–	1.5	–	1.5	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		5	–	5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				25[a]	5	–	2	–	2	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\|h_{fe}\|$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		75				130	–	130	–	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		–	2.25	–	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						–	20	–	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						–	80	–	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		RCP117B		RCP117		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current:											
With emitter open	I_{CBO}	250 100					– –	50 –	– –	– 50	μA
With base open	I_{CEO}		175 70			0 0	– –	100 –	– –	– 100	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10		25[a] 1[a]		20 10	– –	20 10	– –	
Collector-to-Emitter Sustaining Voltage: With base open[b]	$V_{CEO(sus)}$				20[a]	0	250	–	100	–	V
Base-to-Emitter Voltage	V_{BE}		10		25[a]		–	1.5	–	1.5	V
Emitter-to-Base Breakdown Voltage: I_E = 1 mA	$V_{(BR)EBO}$				0		5	–	5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				25[a]	5	–	2	–	2	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 20 MHz	$\lvert h_{fe} \rvert$		20		15		4 (typ.)		4 (typ.)		
Gain-Bandwidth Product	f_T		20		15		80 (typ.)		80 (typ.)		MHz
Second-Breakdown Collector Current: With base forward-biased and t = 0.05 s	$I_{S/b}$		75				130	–	130	–	mA
Three-Terminal Feedback Capacitance (Miller Capacitance)	$C_{b'c}$		20		25		–	2.25	–	2.25	pF
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						–	20	–	20	°C/W
Junction-to-ambient	$R_{\theta JA}$						–	80	–	80	

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO(sus)}$, MUST NOT be measured on a curve tracer.

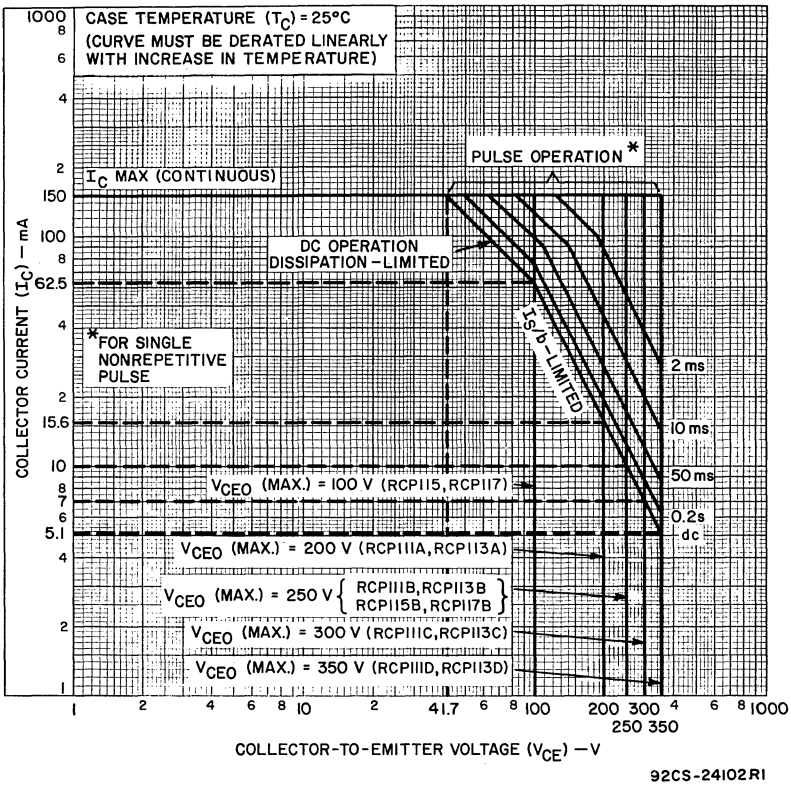


Fig. 1—Maximum operating areas for all types.

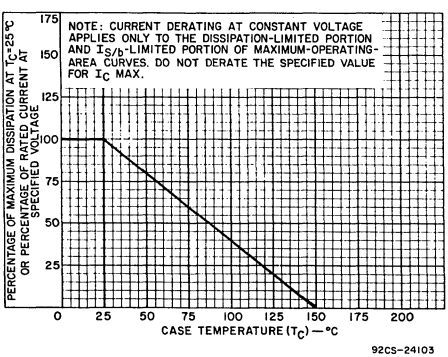


Fig. 2—Dissipation derating curve for all types.

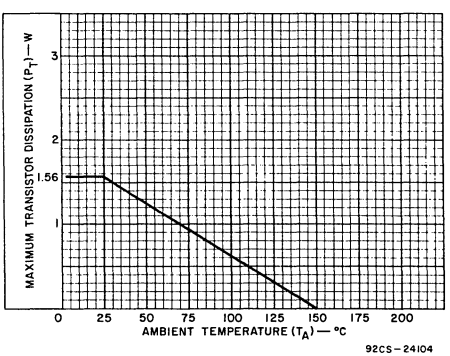


Fig. 3—Dissipation derating curve at ambient temperature for all types.

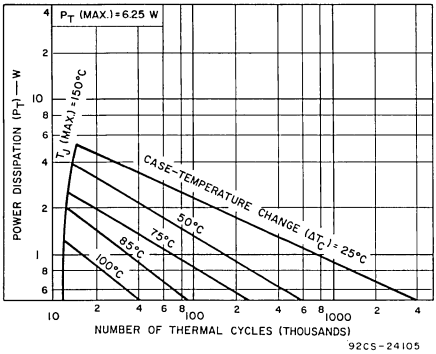


Fig. 4—Thermal-cycling rating chart for all types.

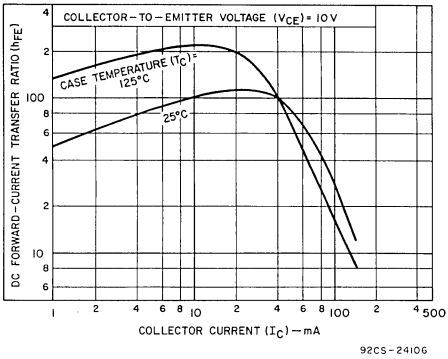


Fig. 5—Typical dc beta characteristics for all types.

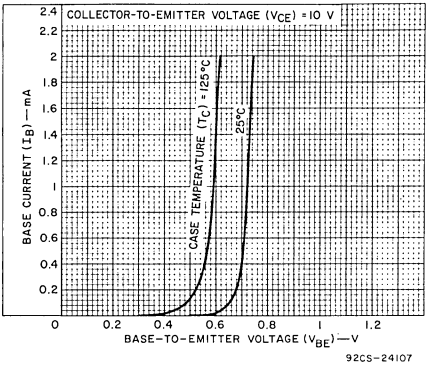


Fig. 6—Typical input characteristics for all types.

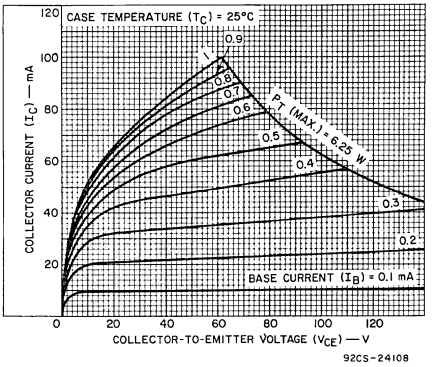


Fig. 7—Typical output characteristics for all types.

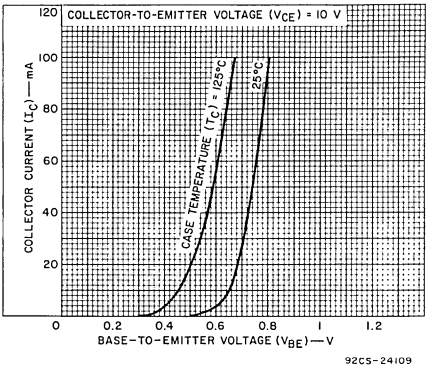


Fig. 8—Typical transfer characteristics for all types.

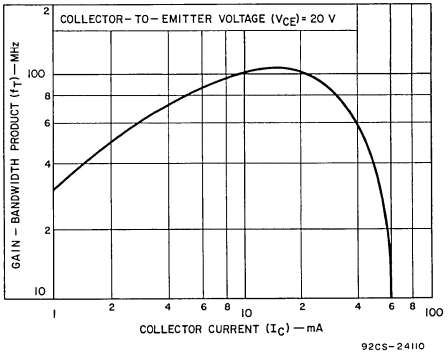


Fig. 9—Typical gain-bandwidth product for all types.

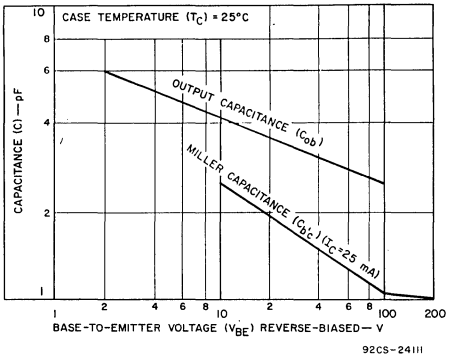
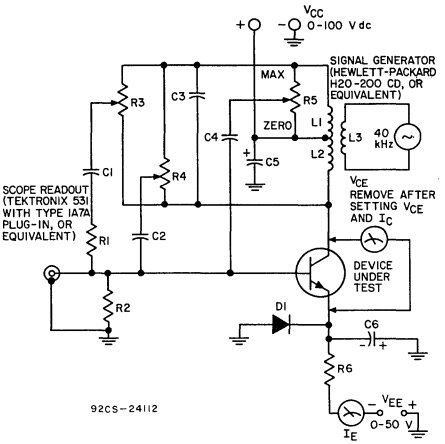


Fig. 10—Typical junction capacitance vs. reverse-bias base-to-emitter voltage.



CALIBRATION AND USE OF $C_{b'c}$ TEST SET

1. Nulling socket and stray capacitance:

   With the socket empty, adjust R3 and R4 for a null output on the readout oscilloscope with the signal generator at approximately half output.

2. Calibration:

   With a known capacitor (smaller than C4) across the collector and base terminals of the device-test socket, a null will appear on the oscilloscope at some setting of R5. Calibrate a readout dial (in pF) on R5 by measuring a range of capacitor values.

   An alternate method is to connect an accurate capacitor across the collector and base terminals and adjust the signal-generator output for a calibrated scope readout, e.g., 1 pF = 100 microvolts (peak).

3. Set-up of operating point V_{CE}, I_C:

   With the set-up transistor in the socket and V_{CC} supply at 10-20 V, set the V_{EE} supply to the desired operating current. Attach the voltmeter (V_{CE}) as shown in the circuit diagram, and adjust V_{CC} to the desired conditions. Remove the voltmeter, and test the units by the method chosen from (2) above.

C1: 1000 pF
C2, C4: 5 pF
C3: 2000 pF
C5: 5 μF, 150 V, electrolytic
C6: 5 μF, 25 V, electrolytic

L1, L2: 40 turns No. 30 bifilar
L3: 40 turns No. 34 bifilar
L1, L2, and L3 are wound on one 1/2 in. (12.7 mm) diameter ferrite rod 2 in. (50.8 mm) long.

R1: 10 MegΩ
R2: 470 Ω
R3, R4: 500 Ω pot., linear taper
R5: 5000 Ω pot., linear taper
R6: 1000 Ω

D1: 1N3195

All resistors are carbon, 1/2 W

Fig. 11—Test set used for Miller capacitance ($C_{b'c}$).