during the cycle to trigger Q_2.

Now that C_2 has been determined, C_1 can be found.

$C_1 = C_2/21 = 0.025 \times 10^{-6}/21$
$= 0.0012$ microfarads.

The circuit was constructed using the components determined above and performed reliably from 0° to 65°C.

Constant-current source controls sweep rate

By James J. Collins

Kollsman Instrument Corp., Syosset, N.Y.

A constant-current generator stage is used in this circuit to obtain linear sweeps ranging from a few microseconds to one second in duration. The constant-current source portion of the circuit, contained within the dashed-line box, consists of Q_2, R_3, R_4, and R_5.

Transistor Q_2, in the constant-current source stage, and transistors Q_3 and Q_4, which are connected in a Darlington amplifier configuration, conduct at all times during the operation of the circuit.

At first, an input voltage $-E_i$ is applied to the base of the emitter-follower Q_1. This voltage maintains Q_1 in conduction, and places nearly $-E_i$ volts at the upper plate of capacitor C through a path consisting of R_2 and D_1.

When the input signal rises to ground, Q_1 is cut off; diode D_1 becomes back biased and also stops conducting.

Now the only current being supplied to the capacitor is the small positive current from the constant-current source. The voltage across C increases linearly from approximately $-E_i$ volts and approaches $+V_{ce}$, the voltage at the collector of Q_2. This process continues until the input pulse is removed—before or when the voltage at the upper plate of C reaches ground potential.

With the return of the input signal to $-E_i$ volts, Q_1 and D_1 conduct, and the upper plate of the capacitor also goes to $-E_i$ volts.

The voltage across a capacitor is defined by:

$V_C = 1/C \int i dt$

With a constant current flowing, this becomes:

$V_C = (i)(t)/C$

In a typical application, with an input pulse voltage ($-E_i$) of -12 volts, the constant-current source was set at two milliamperes. The total sweep time desired was 100 microseconds, and a full 12-volt sweep was also desired. Therefore:

$C = (2 \times 10^{-3})(10^{-4})/12$
$= 0.016$ microfarad

The retrace time T_R (time for the voltage to revert to nearly $-E_i$) is given by:

$T_R = 3\ RC$

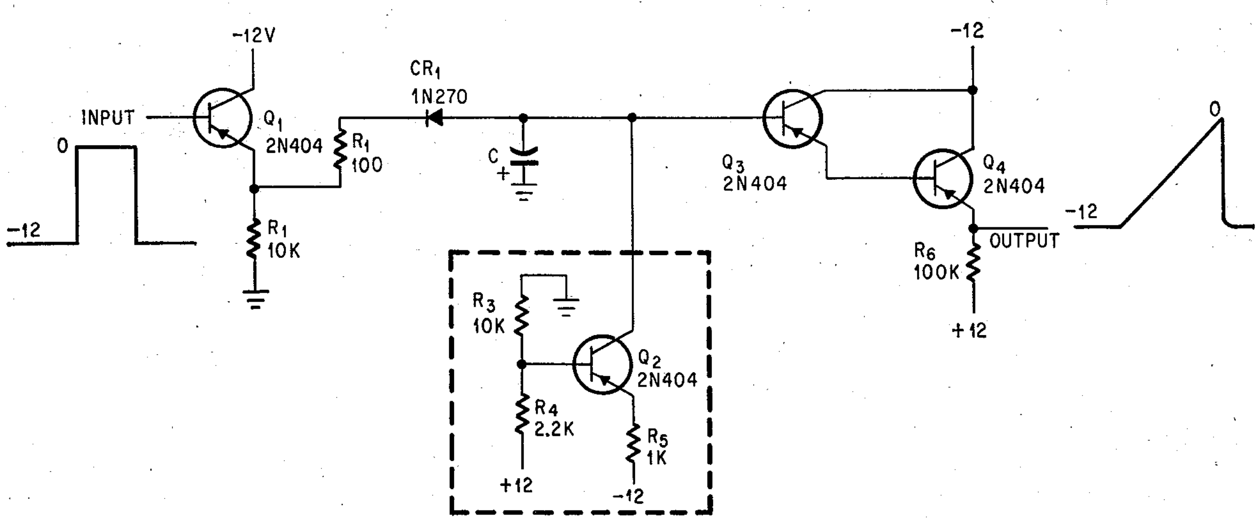
where

$R = (Z_S/\beta_1) + Z_{D1} + R_2$
β_1 = Beta of Q_1
Z_S = Source impedance
Z_{D1} = Forward impedance of D_1

For the example specified above, the retrace time was about four microseconds.

The Darlington connection of Q_3 and Q_4 presents a high input impedance to the sweep circuit and acts as a buffer to the load. For sweep times greater than one second, with good linearity, Q_3 should be replaced with a transistor having high current gain with low base current.

Resistor R_2 was added to the circuit to limit the peak current handled by Q_1 during the discharge of C. Resistor R_2 is 100 ohms.



The constant-current generator stage (shown in dashed box) supplies a 2-milliampere current to the capacitor.