Fast Recharge Circuit for Q-Switched Lasers

The problem:
Q-switched, cavity-dumped lasers employ an electro-optic-effect cell, such as a Pockels cell, to alternately block and release the laser pulse. The Pockels cell requires a high-speed switching circuit that can apply and remove a high voltage. The circuit must switch at rates greater than 5 kHz, should be solid-state to eliminate warmup time, should provide a variable voltage waveform, and should allow polarity reversal.

The solution:
A new solid-state circuit employs complementary transistor switches and can meet all of the stated requirements.

How it's done:
A simplified schematic of the circuit is shown in Figure 1. A high voltage is applied to the input terminal by a dc supply (not shown), and controlling commands are applied to the Q-Switching (QS) and cavity-dumping (CD) terminals. The QS command is applied at a time \( t_0 \) (see Figure 2) to the primary of the high-voltage isolating transformer \( T_1 \). A triggering pulse is produced at the secondary \( T_1 \) and applied directly to fast switch \#1 (a series-connected chain of 2N5401 pnp transistors). Before the signal is applied, the full high voltage is across the fast switch. Upon receipt of the QS command at \( t_0 \), the switch shorts, connecting the anode of diode \( D_1 \), and hence point A, rapidly to the high-voltage source. The rise time at point B (\( t_{RB} \)) may be determined from the following equation (if \( C_1 \) is \( \gg C_B \)).

\[
t_{RB} = \sqrt{\frac{\pi (L) (C_B)}{C_1}}
\]

where

\[
C_B = C_2 + C_{CRYSTAL} + C_{VR2} + C_{FAST SWITCH \#2}
\]

When the voltage level at B exceeds the voltage rating of zener diode \( VR_2 \), further increase is clipped.
At some later time $t_2$, a pulse, applied at terminal CD by a pulse generator (not shown), causes fast switch #2 to short point B to ground. (Fast switch #2 is a series-connected chain of avalanche MPSU04 npn transistors.) This switching completes the generation of a high-voltage pulse suitable for the Pockels Cell. The polarity of the waveform applied to the Pockels Cell may be reversed simply by returning electrode Y to ground instead of the high-voltage source as shown. Another high-voltage pulse may be generated once the voltage at point A has returned to zero. Capacitor $C_1$ isolates and protects fast switch #1 from #2 should a fault develop in either.

**Note:**
No further documentation is available. Specific questions, however, may be directed to:
Technology Utilization Officer
Goddard Space Flight Center
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**Patent status:**
NASA has decided not to apply for a patent.

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