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**Chen et al.**

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(54) **HIGH VOLTAGE START-UP CIRCUIT FOR SWITCHING POWER SUPPLIES**

(58) **Field of Classification Search**

CPC H02M 1/36; H02M 3/33576; H02M 1/0006

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See application file for complete search history.

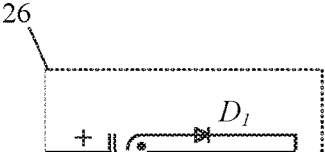
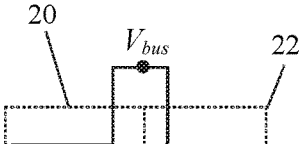
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(73) Assignee: **Queen's University at Kingston,** Kingston (CA)

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FIG. 1 16,



Switching signals  
for primary side  
components



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V<sub>1</sub>

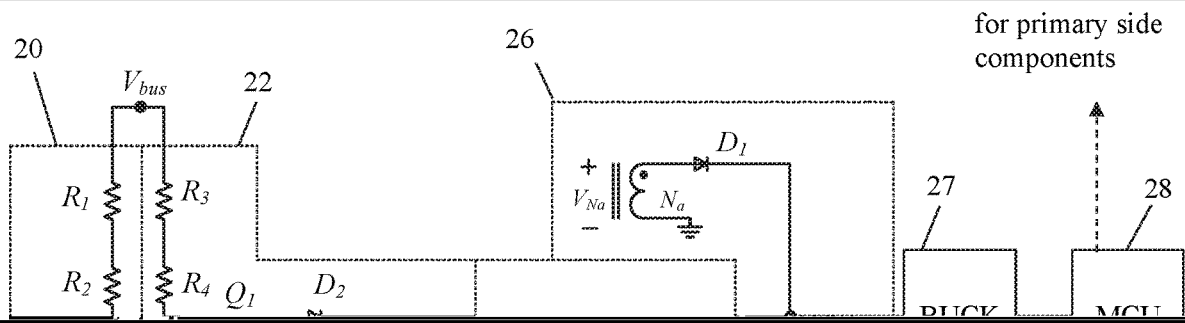
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Switching signals  
for primary side  
components

Switching signals  
for primary side







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**HIGH VOLTAGE START-UP CIRCUIT FOR SWITCHING POWER SUPPLIES**

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one or more switches of the power converter primary side, and disables the start-up circuit when the auxiliary power

RELATED APPLICATION

This application claims the benefit of the filing date of Application No. 62/890,574, filed on 22 Aug. 2020, the contents of which are incorporated herein by reference in

power to the control circuit until the auxiliary power is established.

In one embodiment the control circuit comprises a timer; wherein the timer generates a signal that disables the start-up circuit after a selected time period; wherein the auxiliary power output is established by the end of the selected time

FIELD

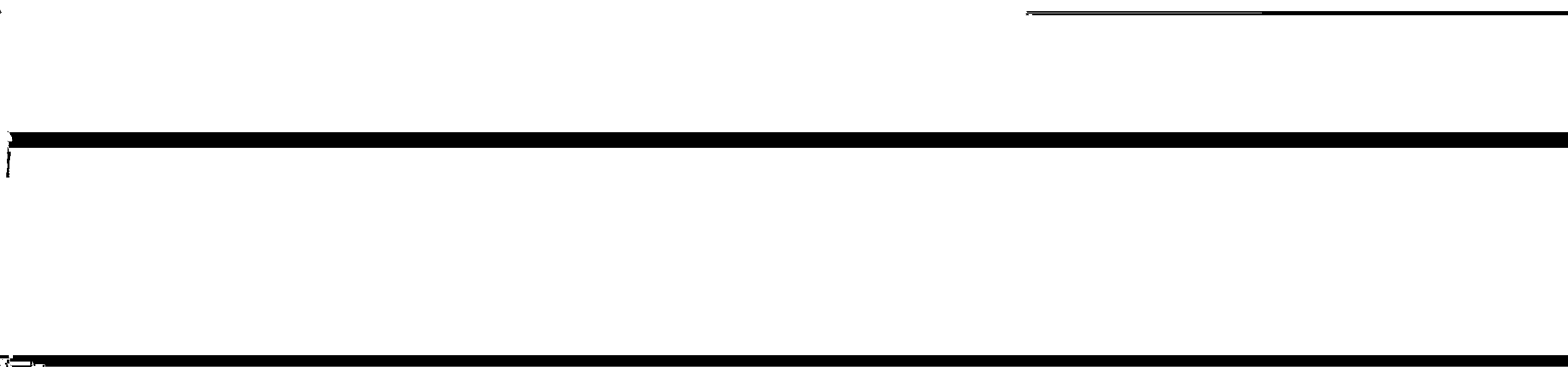
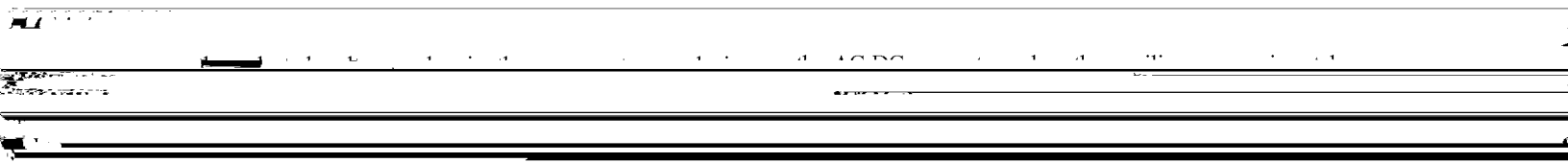
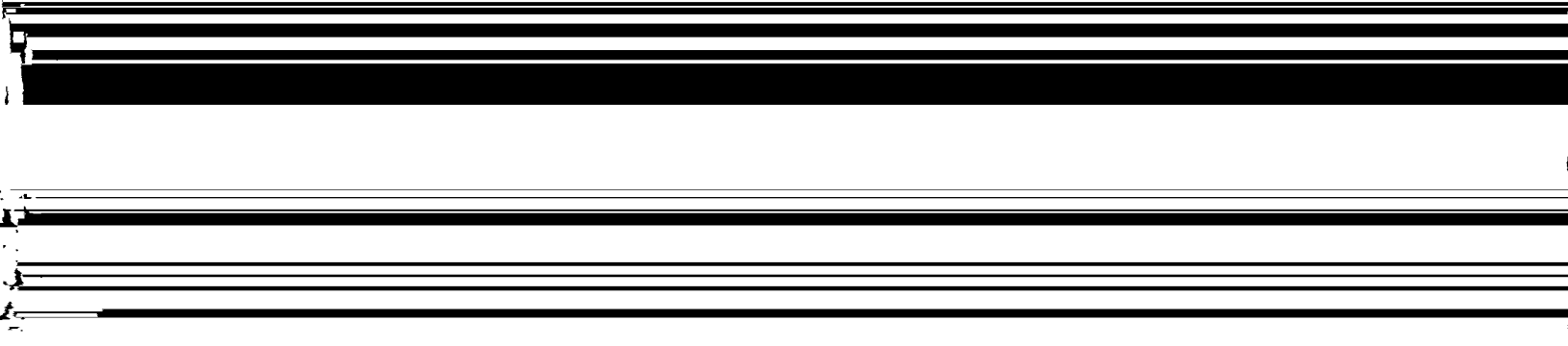
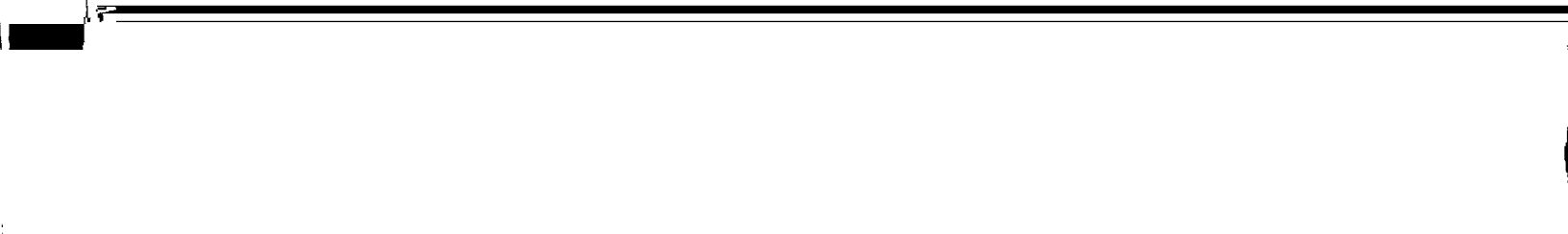
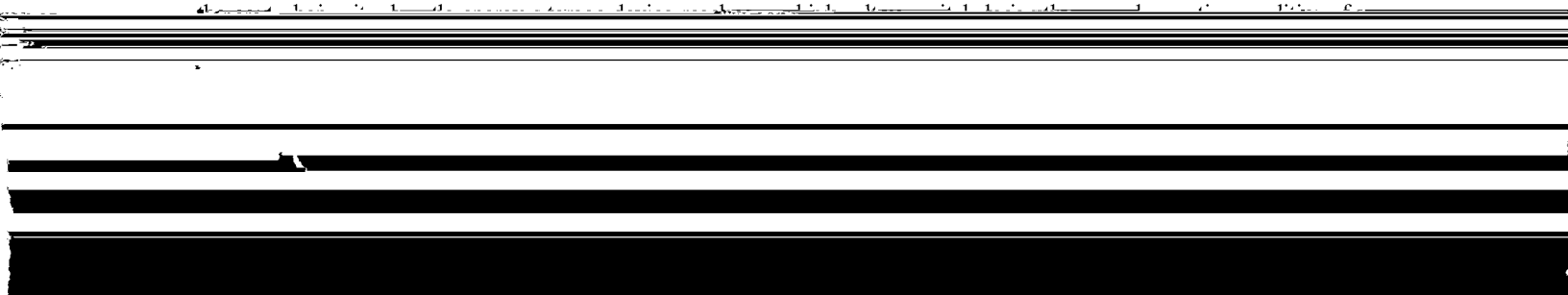
This invention relates to start-up circuits for power supplies. More particularly, the invention relates to high voltage start-up circuits for switching mode power supplies.

In one embodiment the selected time period is about 10 ms to about 1 s.

In one embodiment the selected time period is about 25 ms to about 50 ms.

In one embodiment the control circuit comprises an auxiliary voltage sensor and the control circuit generates a





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controller. After start-up is finished, Q4 is turned on by the control signal, which further turns on Q3 by pulling its gate

to ground. It is noted that the start-up operation is considered finished when the auxiliary winding voltage  $V_{Na}$  is established and provides current to the control circuit (e.g., the Buck converter 27 and the MCU 28, in the embodiment of

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With the circuit in 24, Q2 will remain on when Vc1 is from about 25V to about 5V. Therefore, most of the energy

stored in C1 will be released and Q2 will conduct for a much longer time. While Q2 is on, C1 will provide the power to C2 and the next stage circuit with adequate supplying current. Therefore, the circuit in 24 (Q2, Q5, and Z2, and related components) serves as a latch circuit to keep Q2 on

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after t1. When Q4 is turned on, Q3 will also be turned on and the base voltage of Q1 will be low (below 3.3V, for example).

EQUIVALENTS

While the invention has been described with respect to

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wherein the energy storage device provides power to the control circuit until the auxiliary power is established.

9. The start-up circuit of claim 1, wherein the energy storage device is a capacitor.

5 10. The start-up circuit of claim 1, wherein the sensing circuit comprises a resistor-divider network.

11 The start-up circuit of claim 10, wherein the resistor