Pulse Generator Restoration Notes

January – March 2012, updated August 2012

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Test setup

The pulse generator was powered up on the bench using the WITCH rectifier and stabilizer for all tests. Three switches were provided :-

- Stop switch on A4 (+20 / -10V)
- RCB on / off on A2 (Returned Carry B pulses from A10 / ground)
- Start switch on A3 (-200V / open)

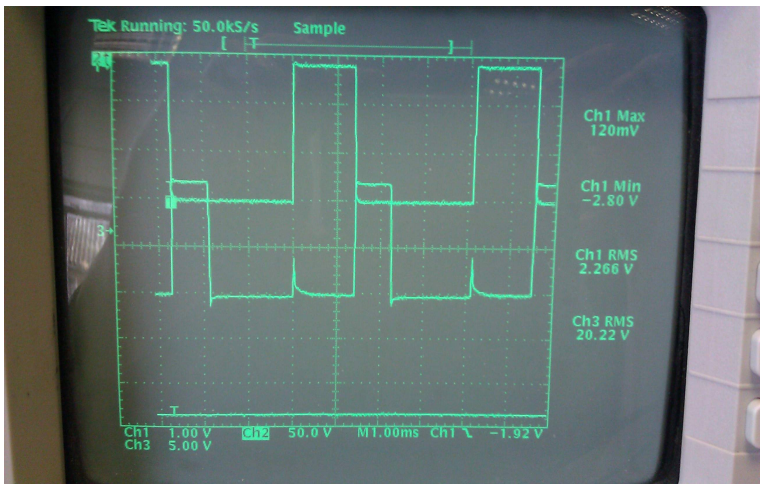
Oscillator

On initial power-up the oscillator worked and pulse widths were observed to be approximately correct. Nominal widths for A and B pulses are 1.5ms.

Over the course of the next few weeks as work progressed, B pulse width became highly unstable and narrower. This fault was traced to C19 (two caps – the larger flat mica to blame). These were replaced with new modern 2200 + 150pF caps on 17th March.

An unusual feature was observed on the +B outputs from V8 – on the anode positive going and on screen negative going narrow pulses coincident with V9 (+A pulse) rising edge. It is unclear exactly how this arises, but is clearly associated with the current which must flow through C19 into the grid of V8, although there is no evidence of a voltage spike on V8 grid. The -ve pulse on the screen output is effectively removed by the following stage (V13) so has no effect on circuit operation.

The anode of V8 goes to A13 and onto Units GA and GB, but is not shown on the schematics of the latter. Investigation of how this signal is used GA and GB will be needed to determine whether the +ve pulse is a problem. Exchanging V8 didn't alter the waveform.

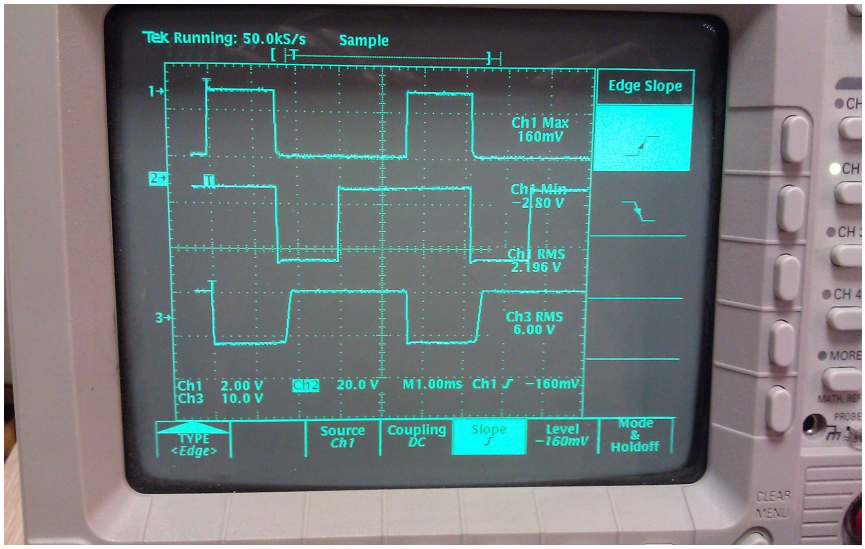


The picture above shows +A and +B pulses before C19 replacement.

The function of the 10n capacitor on V10 anode (-A pulses) was not immediately obvious. It's effect is to heavily round-off the rising pulse edge into V11 and V12. After clamping in the latter stages the rising edge is delayed and noticeably slower (100us). The functional effect is to delay the -A rising edge so that -A and -B pulses overlap slightly, important to ensure the Dekatrons step correctly.

On 17th March V10 failed, causing pulse widths and period to contract. The 6AM5 was replaced with an equivalent NOS EL91.

The photo below shows +A, -B, -A pulses after replacement of C19 and V10.

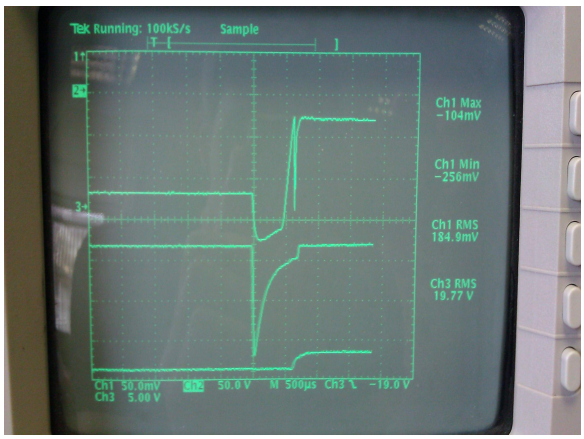


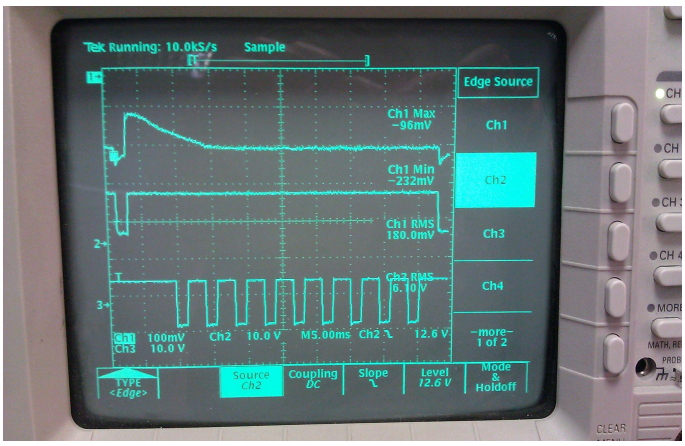
Control Circuit

On initial power-up, the two G1/371K trigger tubes V5, V6 did not work (no priming gap glow). The GTE175M tester was modified to accept G1/371K in an additional socket and the entire stock tested. We had only 7 working and the machine requires six in total (four in the pulse generator and two in Unit GA). The working parts have quite widely varying characteristics – both maintaining voltages and trigger threshold. Two tubes with reasonably well matched V_m were chosen for V5 and V6.

The adjustment of the circuit with RV1-3 is tricky since RV1 also affects the B pulse switching circuit, and V20 in Unit GA as well as the amplitude of the waveform appearing at V5 trigger (coincident with the trailing rising edge of the first RCB pulse). The contemporary “Computer Routine Maintenance” document from Wolverhampton notes that RV2 can be adjusted for two or three returned carry pulses, but it was found to be possible to adjust for one pulse. It isn't clear why more than one would be necessary.

A fault was discovered in this circuit which became more apparent over the period of fault-finding. This was traced to rectifier W2 (actually two germanium in series, probably a Wolverhampton replacement). This was replaced on 17th March with a modern 1N4007 silicon diode. This restored the correct timing of the trigger signal to V5 and eliminated spurious narrow pulses from the B pulse switching outputs.





The left picture above shows the V5 trigger, V4 grid and V5 cathode before the repair, the right hand picture shows V5 trigger, RCB and 9B after replacement of W2.

Round-off Circuit

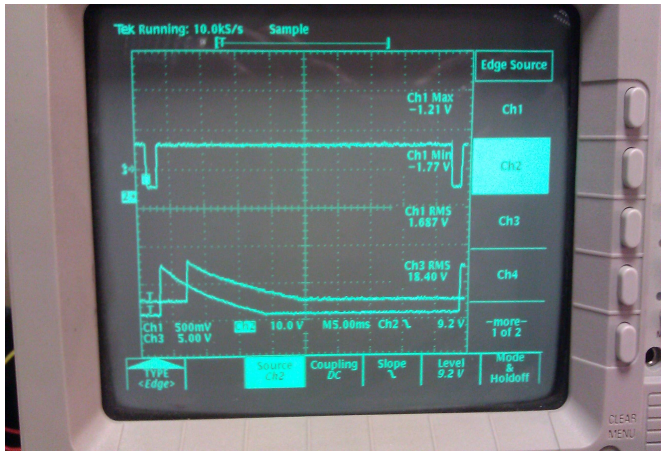
This was tested briefly, but due to the extreme shortage of working trigger tubes and the non essential nature of this circuit it has been left with V22-23 unpopulated.

A Pulse Switching Circuit

No problems were found in this circuit (V11-12) and all the clamping diodes are working.

B Pulse Switching Circuit

As noted above RV1 must be adjusted correctly to ensure waveform z (from trailing edge of RCB pulses) is not too large relative to waveform y (from trailing edge of first normal B pulse). The picture below shows correct adjustment – RCB, z, y.

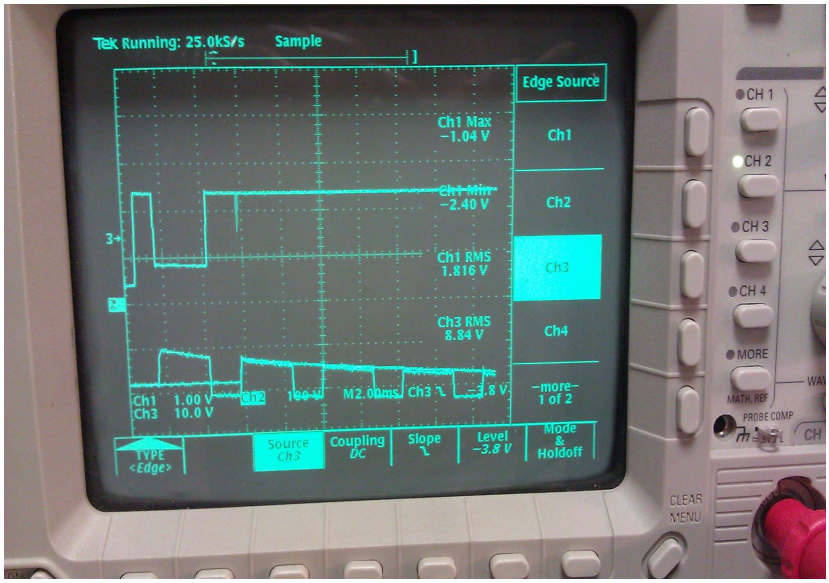


B Pulse Output Stages

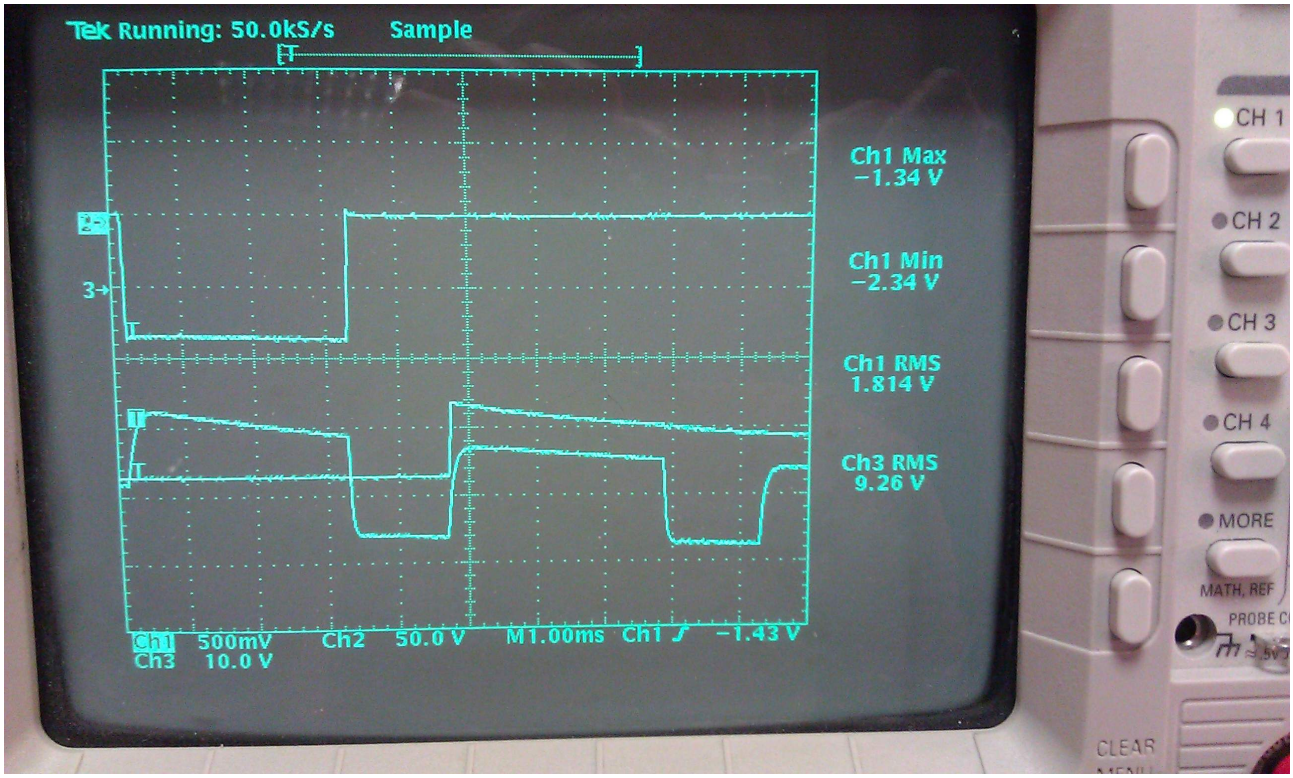
No problems were found in this circuit (V17-19, V25). However during early integration testing of the machine it was noted that send B pulses from V19 (SK21) only fall to around -50V, with RV6 at the limit of adjustment. To correct this problem the bias on RV6 was rewired from -200V to -180V, which now gives plenty of adjustment margin.

Trigger Valve Anode Waveform Circuit

These circuits produced the correct waveforms but with narrow spikes coincident with the rising edge of B pulses. These were traced to V20, the output of which drives SK3 and is mixed into SK2. Initially rectifier W29 was suspected, but temporary substitution with a silicon diode didn't alter the symptom. The picture below shows SK2, and V20 grids.

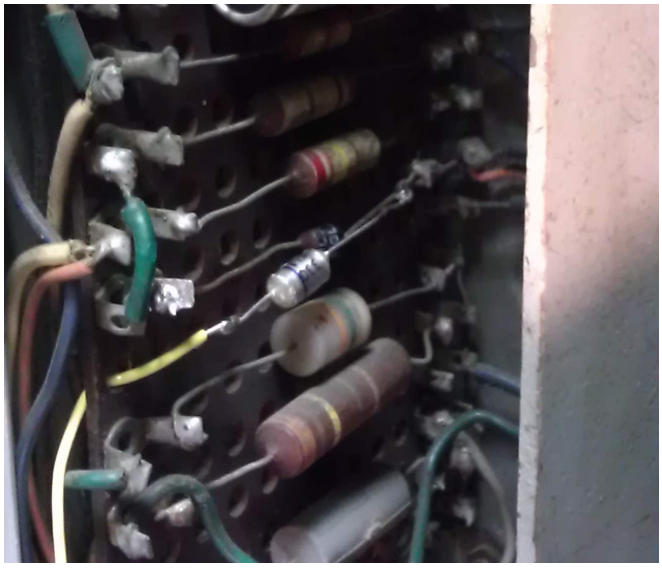


The problem is hard to see in this picture but there is ringing on the rising edges of the B pulses mixed into waveform z which is compared with waveform y by V20. This problem was solved by adding a 330pF capacitor from the junction of W29/R60 to -180V, to slow down the rising edges. The picture below shows the waveforms on SK3 and V20 grids after the capacitor was added.

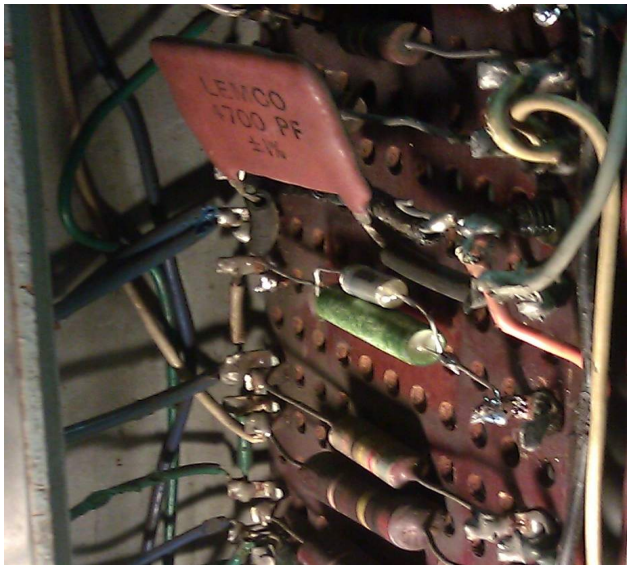


Circuit Modifications

Capacitor on W29



Replacement C19



Replacement W2