EN-Q'ING*: A SIMPLER MODEL TEST

Yuuki KAWARASAKI and Tokio SHOJI
Department of Physics, JAERI
Tokai, Ibaraki 319-11

An alternative method, en-Q'ing versus de-Q'ing, is proposed for regulation of the resonantly charged voltage onto the pulse-forming network(PFN) in a line-type pulse modulator.
A simpler model test experimentally proves the function.
The circuitries for practical use are briefly discussed.

Introduction

A technique, so-called de-Q'ing/1/ is now well known for regulation of the resonantly charged voltage onto the capacitors in the PFN against the voltage fluctuation of a DC power supply in a line-type pulse modulator. In this method, an excess electric power is forced to be thermally dissipated in an external resistor to keep successive values of the voltage constsnt.

If there happens a case, in which less voltage is charged resonantly onto the capacitors, then an additive method, inverse to the deducting one, can easily be conceived to be applicable and then efficient/2/, because no thermal dissipation is accompanied in principle.

Description

Fig.1 shows: (a) a circuit diagram of a pulse modulator with de-Q'ing, (b) waveforms of resonantly charging current and voltage with the modification of the purpose; both de- and en-Q'ing and (c) a simplified en-Q'ing schematic.

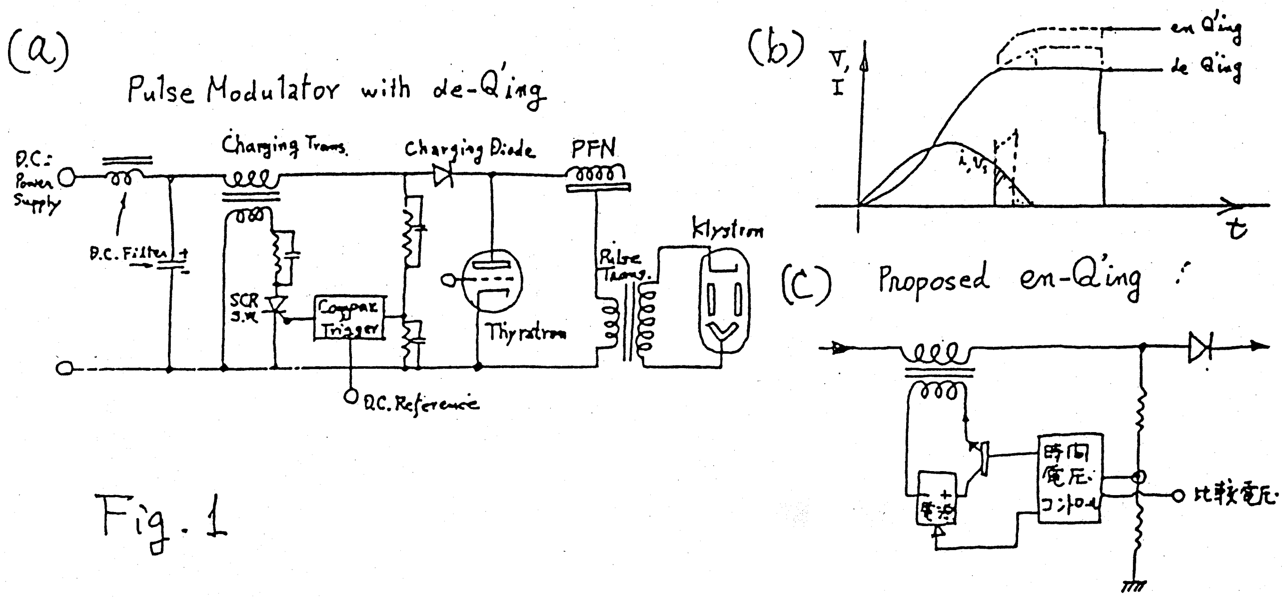


Fig. 1

The value of the charged voltage V_c can be expressed as,

$$V_c = 1/C_{PFN} \cdot \int_{t_0}^{t_1} i_c(t)\, dt,$$

where C_{PFN} is the capacitance of the PFN's condensors and $i_c(t)$ is the charging current flowing through a charging reactor; $t_c(i)$ varies as a function of time, i.e., in a form of positive half of a sinusoidal curve, t_0 and t_1 being the time at which the current flow starts and stops, respectively.

In the de-Q'ing, the later portion of the curve is forced to be directed to the external load instead of to the PFN's. If one can change the waveform of the charging current in a manner that a time-integral value of the current increases, then the charged voltage will be expected to be increased. A methode for the above can be of the superposition of an externally applied pulse, whose magnitude and duration are thus parameters of the regulation. Numerical analysis would include nonlinear element, because the resonant condition should be perturbed.

A model test

Fig. 2 shows the circuit diagram used for a model test.

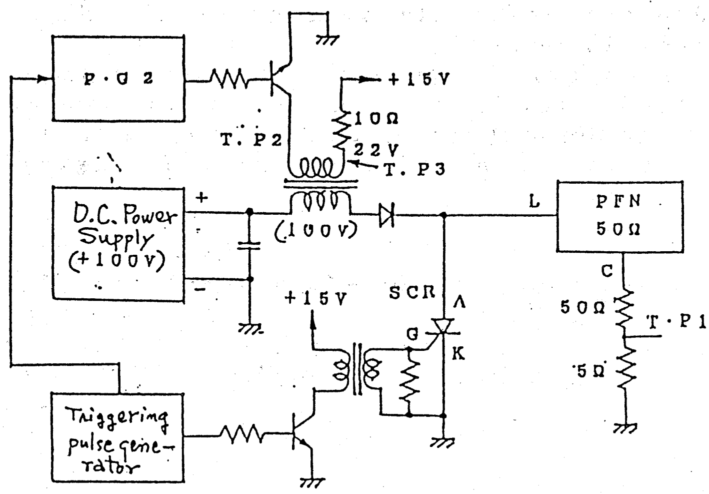
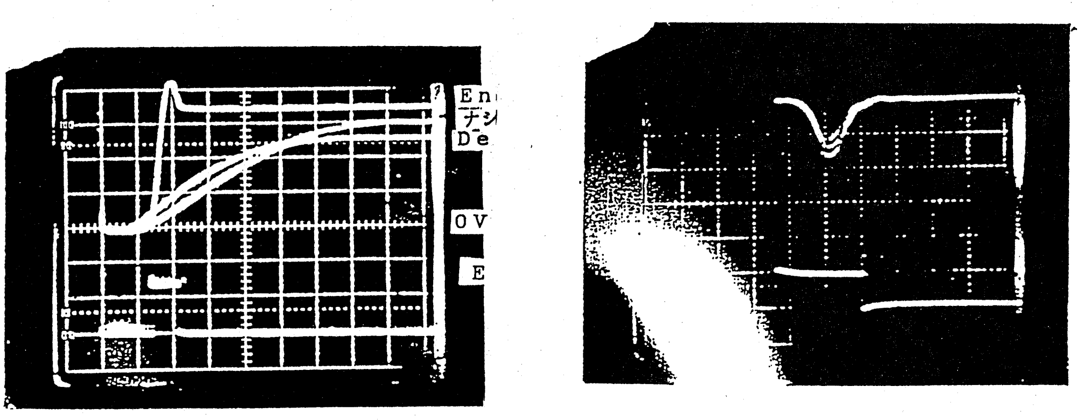


Fig.2

As a resonant reactor with a secondary winding, a commercially available, small transformer, say, heater trans., was here used. A switching element was conventionally a SCR(silicon controlled rectifier). Testing manner was also orthodox.

Fig. 3 is a photograph of the waveforms: (a) charging currents, from topmost with en-Q'ing, without modification and with de-Q'ing and (b) output pulses.



(a) (b)

Fig.3.

Discussions

The charging waveform with en-Q'ing shows a steep rise at the time the external pulse superimpoesed. This seems unlikely in a real modulator, while in the model test an amount of modificating pulse would suposingly be too large compared to main flow of the charging current.

The de-Q'ing was here realized by shunting the reactor with a resistor, which acted as genuine de-Q'ing.

For practical use, a most crucial element should be here the transistor, supplying electric power of some MW to tens MW. Multiple transistors in parallel and serial connection could fulfil the condition. Another candidate should also be SCRs with a much complicated control technique.

For control, fast sensing on the varying voltage is possible and the fast calculation(e.g., in analogue) on an amount of modifying power can be achieved using semiconductor devices or elements with aid of a timing signal from the triggering pulse.

Reference

* Patent pending

1) R.B.Neal, ed.:"The Stanford Two-Mile Accelerator"(1968) W.A.Benjamin, Inc., P.427
2) Y.Kawarasaki: Proc. of Workshop on Electron Linac and Stretcher for the Next Plan at Kakuriken, P.128