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SOME APPLICATIONS OF THE TCA 280 A, AN INTEGRATED THYRISTOR GATE CONTROL CIRCUIT

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1. Introduction

A series of fourteen programmable dc power supplies[1)], delivered by industry (Systron-Donner), are going to allow pulse to pulse variations of current in the PSB injection quadrupoles, as required for beam intensity modulation.

The electronics of these power supplies include the integrated thyristor gate control circuit TCA 280A [2)] (Philips), which drives the power stage of the pre-regulator.

An other integrated gate control circuit, the UAA 145 (AEG-Telefunken), has been tested earlier[3)] and was intended to be used for a number of new power supplies (ΔQ, $\int Bdl$, etc.); it was decided, for reasons of standardisation, to comparatively test the TCA 280 A, which has a wider range of applications (static switches, burst firing, gate control with single or multiple pulses, etc.).

2. Basic mode of operation

The circuit lay-out of the TCA 280 A is shown in Fig. 1a and 1b; its mode of operation is as follows. The ac synchronizing voltage also produces the auxiliary dc voltage (pin 11), so that capacitor C_2 is charged up exponentially and discharged at each zero crossing by the transistors T_{20}, T_{21}. The voltage saw-tooth obtained (pin 2) is fed to the differential amplifier T_8, T_9 (pin 6) and compared to the control voltage U_{st} (pin 5).

The resulting positive voltage step (pin 7) should determine the gate triggering instant.

Mainly two cases are of interest to drive ac thyristor controllers or rectifiers:

a) to obtain a pulse train at the output (pin 10) the circuit is connected as shown in Fig. 1a. The positive voltage at pin 7 charges repeatedly the capacitor C_3 up to the zener voltage of Z_3 and, each time the thyristor T_{12}-T_{13} is fired, a pulse is produced via transistors T_{14}, T_{16}, while T_{15} is permanently blocked.

In practice a time interval elapses between the instant when pin 7 becomes positive and the first pulse edge at the output (pin 10); this time depends on the applied voltage and the actual value of certain components (C_4, R_{14}).

b) When single pulses are required the circuit is connected as in Fig. 1b. The rising edge of the voltage at pin 7 blocks through capacitor C_2' the transistor T_{15}, which otherwise is "ON", and a pulse is produced by transistor T_{16} through zener diode Z_4 and resistor R_{15}.

3. How to upgrade circuit performances

The suggested circuit layouts have been modified to obtain better reproducibility for multiphase applications, to suppress the initial delay in the case of a train of firing pulses and to separate the pulses of the two half-waves.

The main modifications and additions, as shown in Fig. 2, are:

- a constant current generator to make the ramps linear and adjustable
- a buffer amplifier to match the impedance between the ramp signals (pin 2) and the comparator
- separate ± 15 V auxiliary voltages
- the amplification of the synchronizing voltage to obtain better zero crossing and a more reprodubile discharge of the capacitor C_2
- the limitation of the reference voltage U_{in} to a preselected value, before feeding it as U_{st} to pin 5, in order to limit the firing angle α_{max} as required by the actual application
- logic circuits, which separate exclusively the pulse trains of the two synchronizing half-waves
- in order to avoid, in the case of an ac thyristor controller, accidental conduction over 180^0 of one half-wave, due to the pulses of the opposite half-wave near zero crossing, a circuit is added which suppresses the firing pulses 5^0 el before and after zero crossing and also defines α_{min};

- to obtain a pulse train without any unwanted initial delay both feature of Fig. 1a and 1b are included. A pulse is produced as the reference voltage U_{St} crosses the ramp followed by a train of pulses during the rest of the half sine wave.

Some signals observed in the modified circuit are shown in Figs. 3 & 4.

4. Conclusion

The desired performances, as required for magnet power supplies, can also be obtained in the case of the TCA 280 A, by means of a number of modifications to the application circuits. Nevertheless the extent of these additions turns out to be greater than in the case of the UAA 145.

Consequently, one can confirm the UAA 145 to be a better choice for the envisaged applications, while due to its flexibility, the TCA 280 A is interesting for other special cases.

5. References

1. M. Mêtais, Les nouvelles alimentations des quadrupôles de la ligne d'injection du PSB (report to appear).

2. Philips, Informationen über integrierte Schaltunger Nr. 22, TCA 280, eine monolithische integrierte Schaltung zum Betrieb von Thyristoren und Triacs.

3. F. Völker, The integrated thyristor gate control circuit UAA 145, PS/BR/Note 77-14.

Acknowledgements

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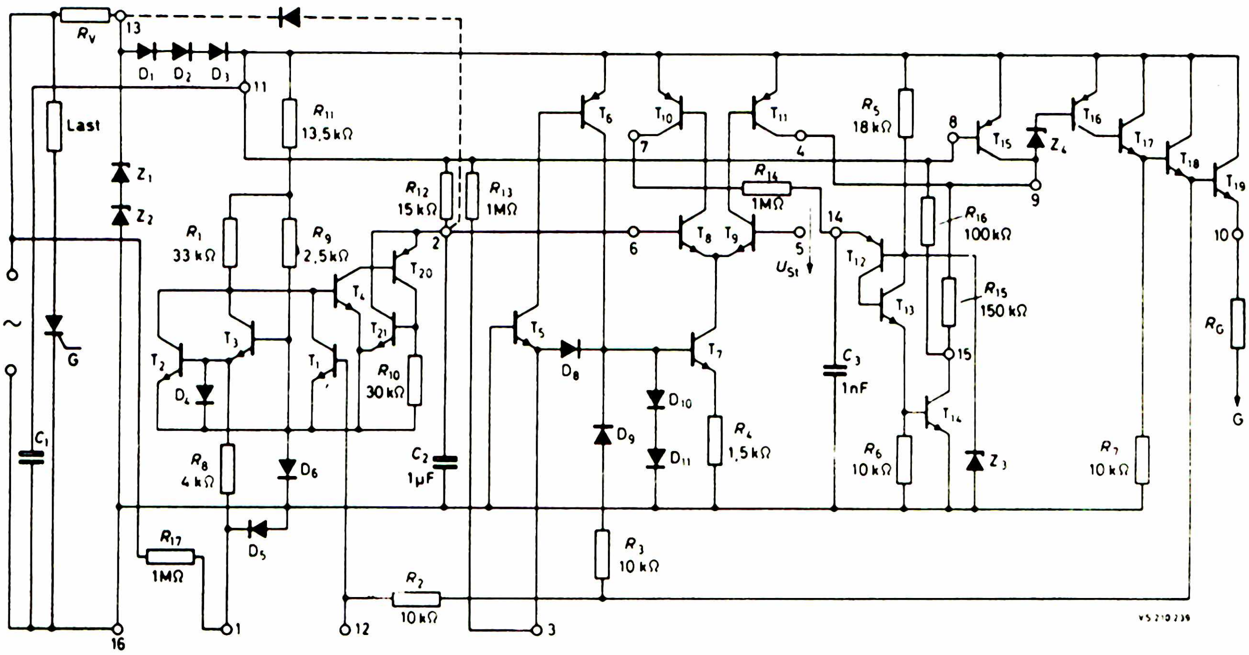


FIG. 1a - Circuit layout to obtain trains of pulses

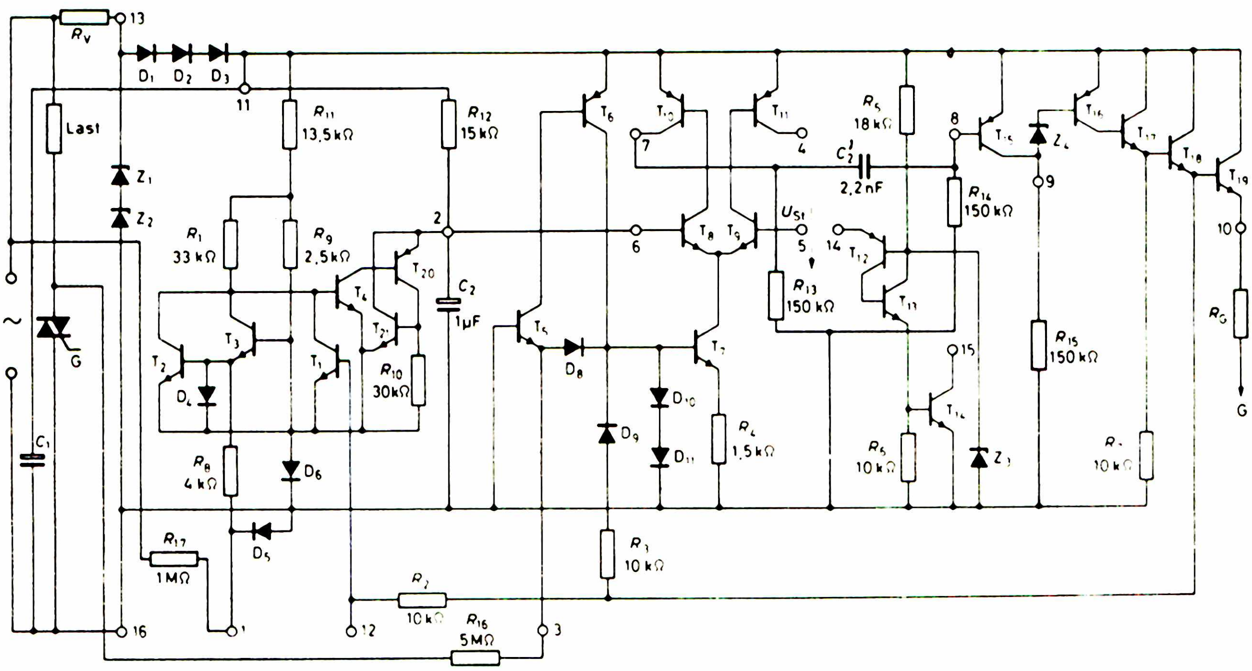


FIG. 1b - Circuit layout to obtain single pulses

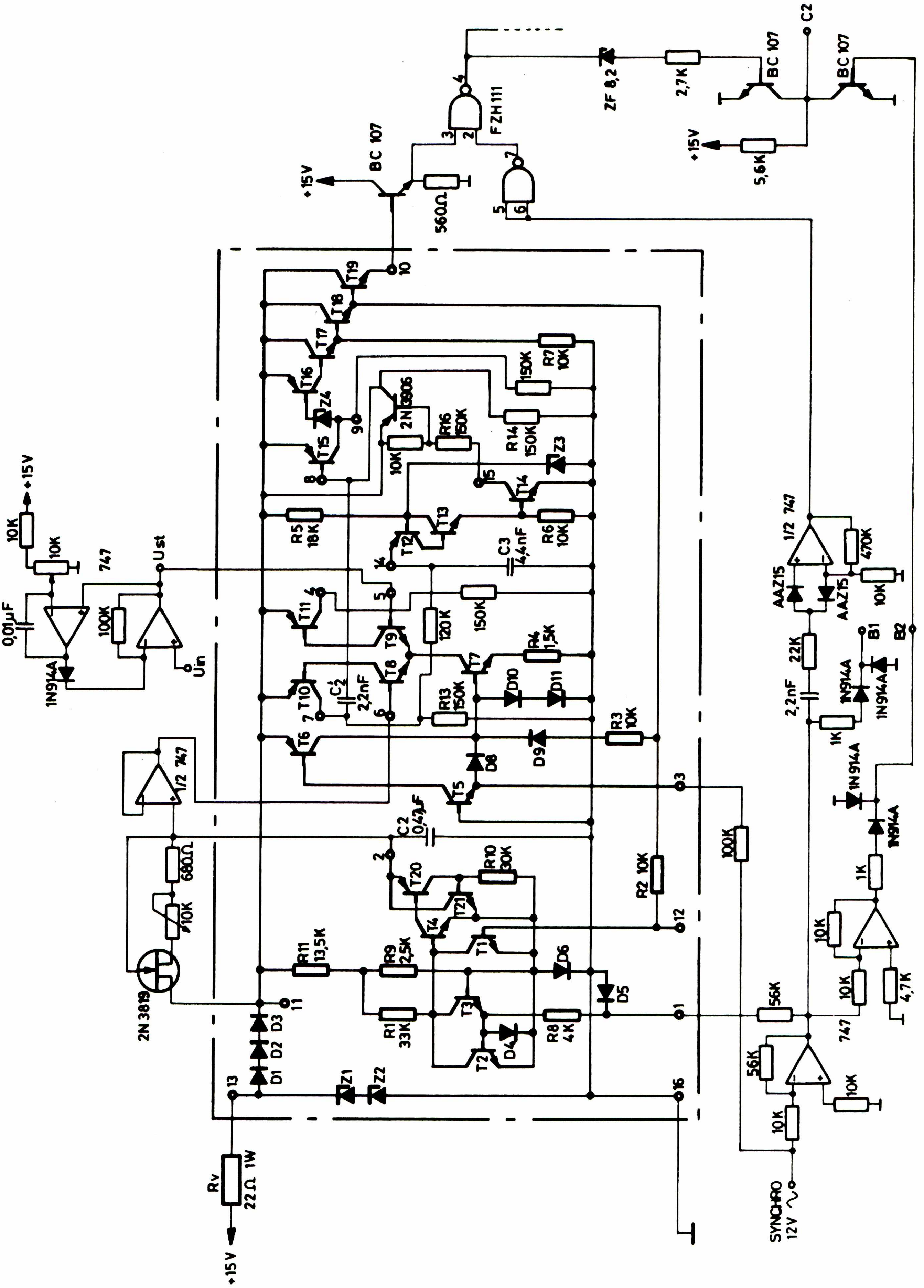
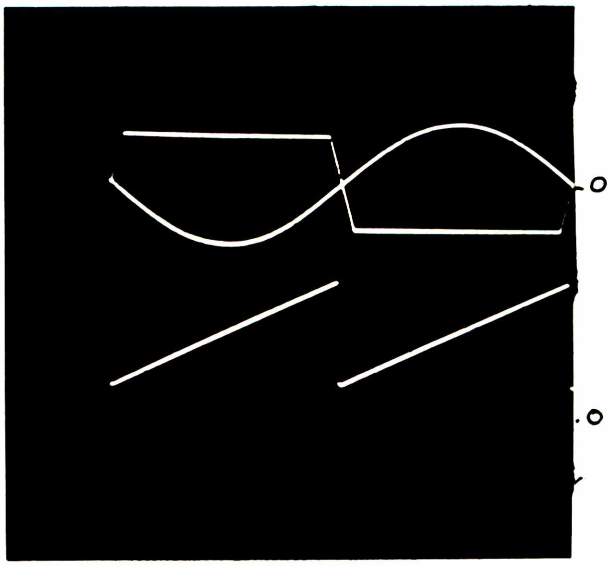
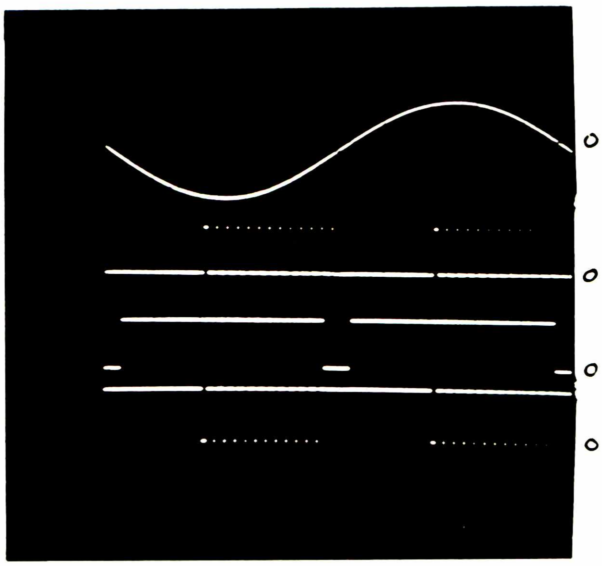


FIG. 2 - Modified circuit layout



<u>FIG. 3</u> - Synchronizing sinusoidal and trapezoidal waveforms — 10 V/div
Ramps at pin 2 — 2 V/div
} 2 ms/div



<u>FIG. 4</u> - Synchronizing waveforms
Pulses at ouput (pin 10)
Pulses at input of FZH 111 (pin 2)
Pulses at output of FZH 111(pin 4)
} 10 V/div, 2 ms/div