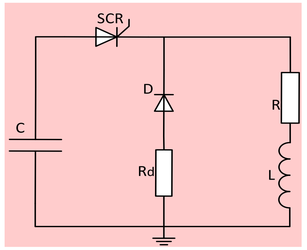
Preliminary Design of New Type of Power Supply Similar to Flat-top Pulsed High Magnetic Fields

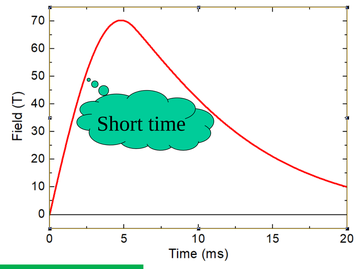
W. Fei[1,2], X.N.Liu[1], M.H.Song[1], C.Wang[1,2]， Y.H.Xu[1]

[1]High Magnetic Field Laboratory, Chinese Academy of Sciences. Hefei, 230031, China.

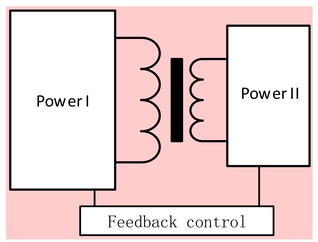
[2]University of Science and Technology of China, Hefei 230026, P. R. China

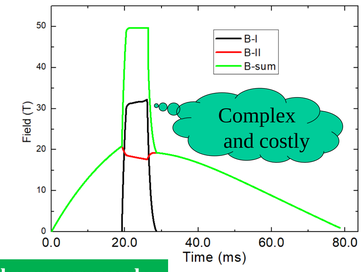
***Abstract*—**This paper describes a simple, compact and cost-effective capacitor type pulse power supply. It only needs a single coil magnet load and two capacitors with different voltage and capacity levels to form a special circuit structure. It can realize a pulse magnetic field similar to flat top wave, so as to meet some scientific experiments with higher requirements for magnetic field strength and stability. Through reasonable design, the rising edge of the magnetic field waveform is accelerated, and the stability of the top of the waveform is maintained for a relatively long time. The addition of artificial zero crossing switch (AZCS) enables the magnet energy to be quickly transferred and released in the falling stage of the magnetic field. This design reduces the inverse voltage caused by capacitor charging and reduces the heat accumulation of the magnet, Thus, the waiting time for magnet cooling is shortened and the service life of magnet is improved.





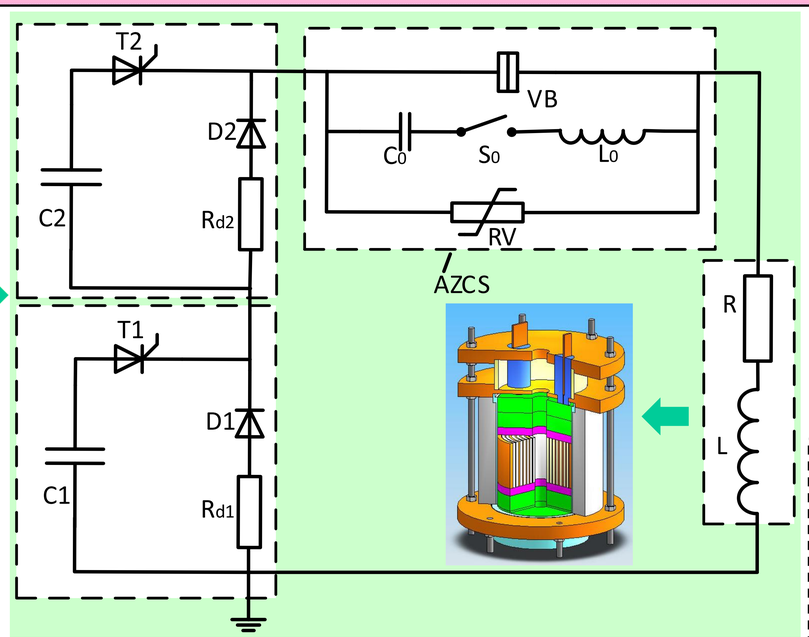
Short pulse power supply

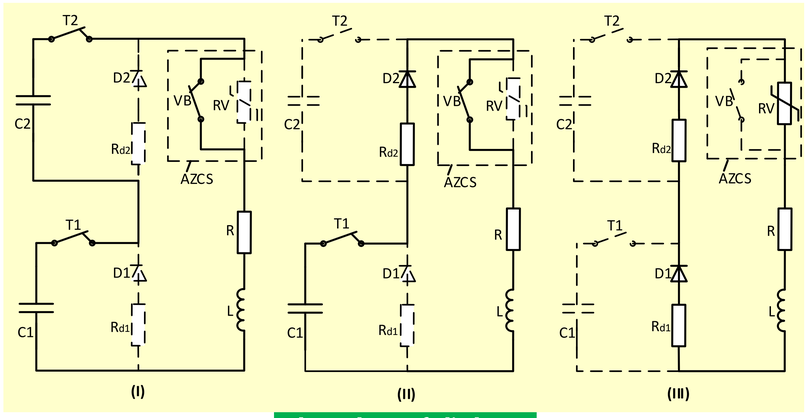




Flat top wave pulse power supply (double coil coupling)

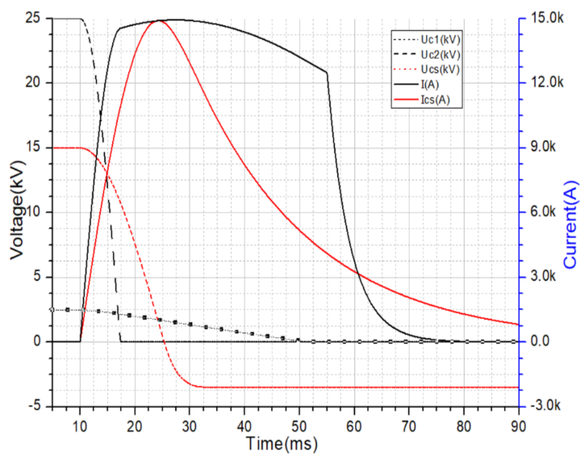
A New Type of Pulse Flat-top Wave Power Supply Based Single-coil Magnet





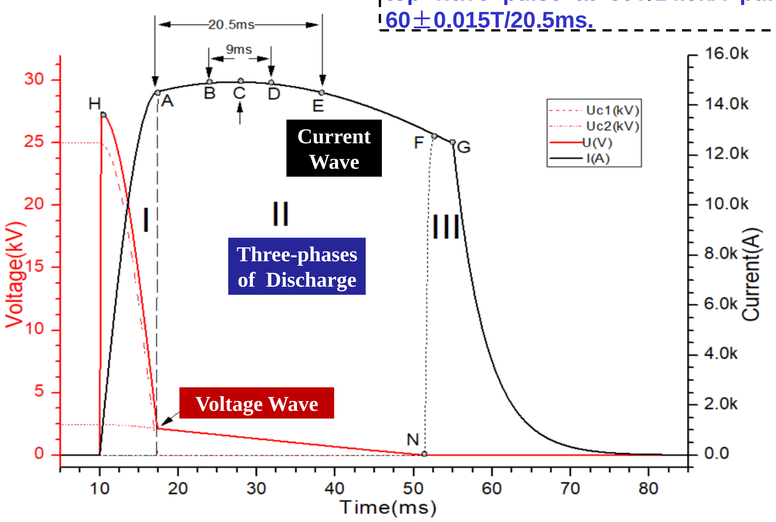
Three-phases of discharge

The new pulse power supply can be used for single coil pulse magnet. Through the combination of high-voltage capacitor bank and low-voltage capacitor bank, the discharge process is mainly divided into three stages. Phase I) ,the capacitor bank is discharged in series to quickly generate high-strength magnetic field. Phase II) , the continuous discharge of low-voltage capacitor bank is mainly used to maintain the relative stability of flat top wave . Phase III) , the energy of the magnet can be released quickly through freewheeling circuit and artifical zero crossing. Through reasonable parameter matching and simulation verification, the magnet can achieve very good flat top wave pulse at 60T/14.9kA pulse magnetic, flat-top reaching 60±0.003T/9ms and 60±0.015T/20.5ms.



Comparison of discharge waveform

The new flat top wave pulse power supply uses the basic principle that the LC resonance period depends on its inherent parameters, based on capacitor energy storage and single coil magnet load, adopts a special circuit topology, connects the low-voltage large capacitor bank and high-voltage small capacitor bank in series, and discharges them together to the magnet. In the later stage of discharge, it realizes rapid energy transfer through freewheeling circuit and artificial zero crossing switching (AZCS) technology. The waiting time for the next experiment is reduced. After reasonable parameter design and matching, it not only has the characteristics of simple structure of traditional short pulse power supply, but also its capacitor reverse voltage is very low, which improves the service life of the capacitor. In addition, this design can realize long pulse flat top wave pulse magnetic field without dual power supply, double coil structure and complex feedback control, which greatly reduces the cost.



Parameter Comparison

Facility	H_{max} (T)	$H_{stablity}$ (T)	Flat-top durtion (ms)	Remarks
NHMFL	60	…	100	
WHMFC	50	±0.25	100	
HLD	55.2	±1	70	
WHMFC	41	±0.09	6	
ISSP	60.6	±0.005	2	
CHMFL	**60**	**±0.003**	**9**	Simulation data
	60	**±0.015**	**20.5**	