RAN65

10-KILOJOULE SCR PULSER

by

J. P. Kitchen, D. C. dePackh, and H. R. Roess*

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The pulser is designed to provide a peak current of approximately 20,000 amperes at 400 Volts, d.c. to a 30 μh solenoid or other coil. The energy stored in the charging circuit at this voltage is 9600 joules. The intense magnetic field created on the axis of the coil can be used for focusing electrons emitted from the multiple-needle cathode of an electron gun and for other purposes.

Operation of the pulser consists of the charging of capacitance through a charging resistor and the sudden discharge of the energy stored in the capacitance by means of the silicon controlled rectifier (SCR), through an inductance (see figure 1). In order that energy be conserved $\frac{1}{2}C_T V^2 = \frac{1}{2}LI^2$, or $I = \sqrt{\frac{C_T}{L}}\, V$. Because of current limitations on the SCR's, it is necessary to distribute the current so as not to exceed the SCR rating, and this is done by forming ten parallel rows of capacitors and discharging each row through an SCR. The total capacitance

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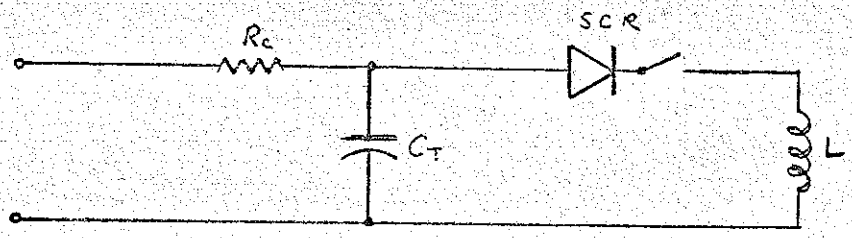
*Retired from Government 30 September 1967.

Fig. 1



Equivalent charging circuit.

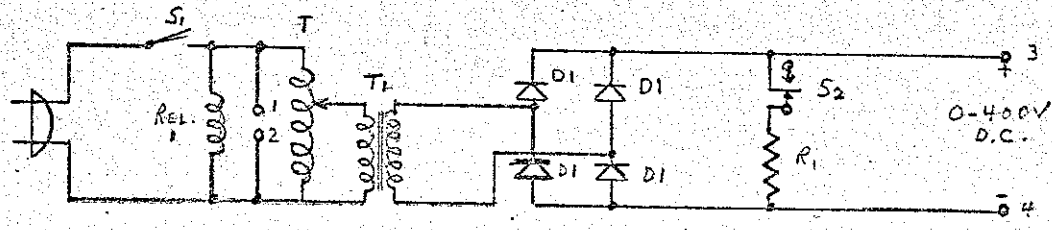


Fig. 2(a) - Power supply

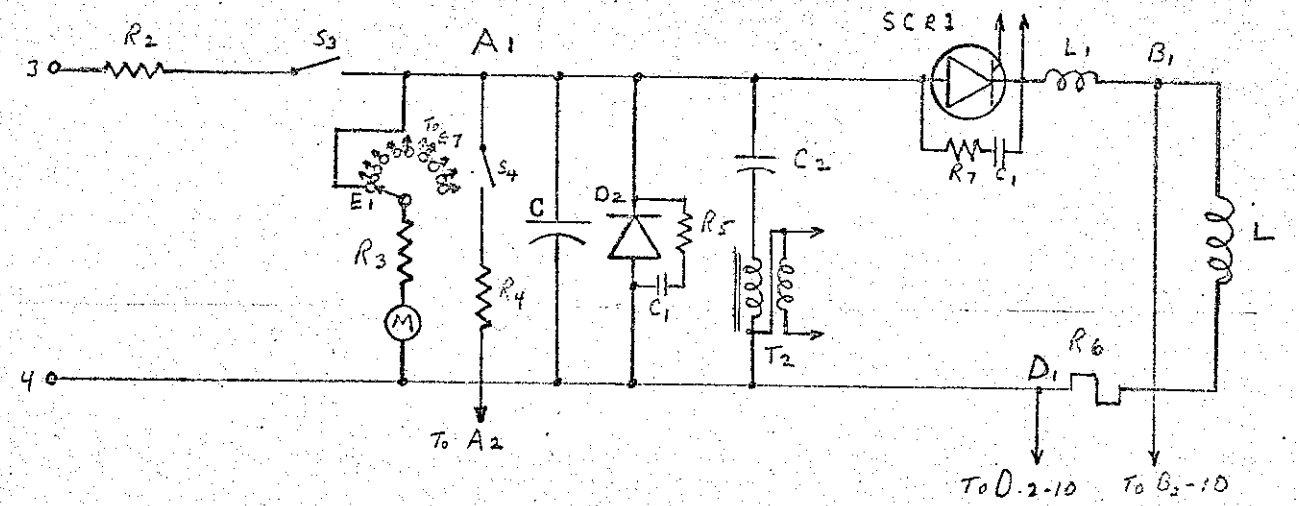


Fig. 2b - A typical row

C_T, then becomes nC where n is the number of rows and C is the capacitance of each row. For fixed C/L, $I_m = k\sqrt{n}\,V$.

One row is shown in figure 2. R_6 is an equalizing resistor which insures that the dc voltage across each SCR will be the same (provided there is no leakage in the capacitors). D_2 is used to provide a short circuit for negative-going currents which would damage the electrolytic capacitors. R_5, C_1, R_7, and C_1 limit the rate of rise of voltage across the D_2's and SCR_1's, within safe limits. C_2 and T_2 are part of the monitoring system. When a bank is discharged, the drop in potential across C_2 appears as in impulse at the primary of T_2 where it is stepped up and inverted and used to trigger SCR_2 (see figure 4). L_1 acts as a choke to limit the effect of stray capacity in inductor L. This effect is manifested by a positive voltage spike appearing at the cathode of an SCR_1, which, if not impeded by L_1, could prevent the SCR_1 from firing.

Figure 3, shows the trigger circuit used to trigger the SCR_1's. T_3 is a 10-secondary pulse transformer which supplies each SCR_1 with a separate trigger pulse. D_3 blocks any negative going pulse from reaching the gate of SCR_1. D_4 (a zener) limits the gate voltage to a safe level.

The monitoring system is shown in figure 4. When a bank discharges, the impulse from T_2 fires an SCR_2, P_{in} turns on and current flowing through R_9 produces a gate signal which turns on SCR_3. C_8 begins to charge through R_{11} and when the voltage across C_8 exceeds the reverse bias at the emitter of Q_1, the UJT will

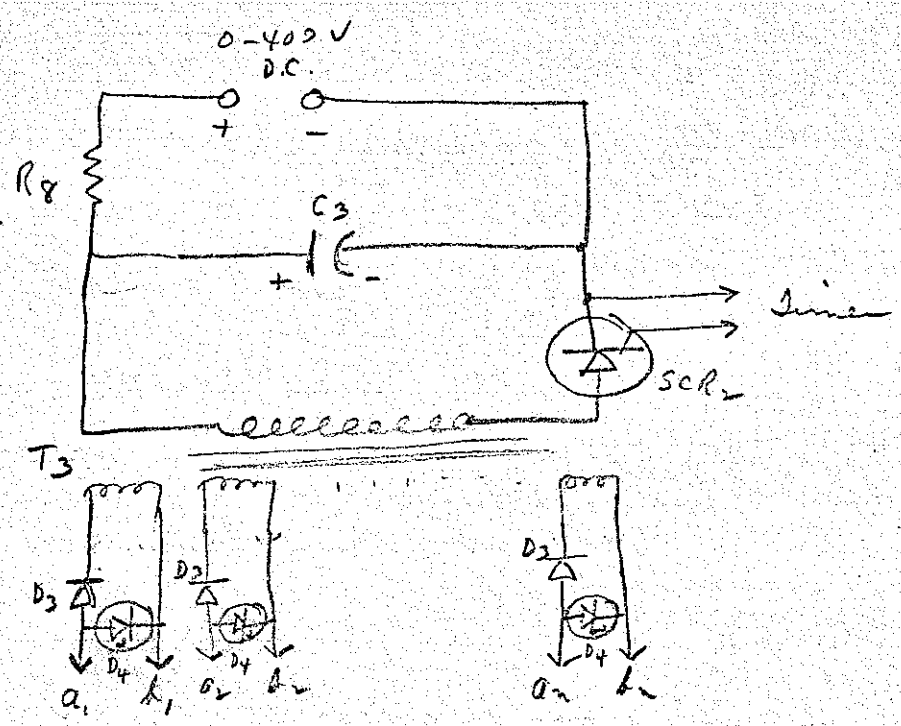
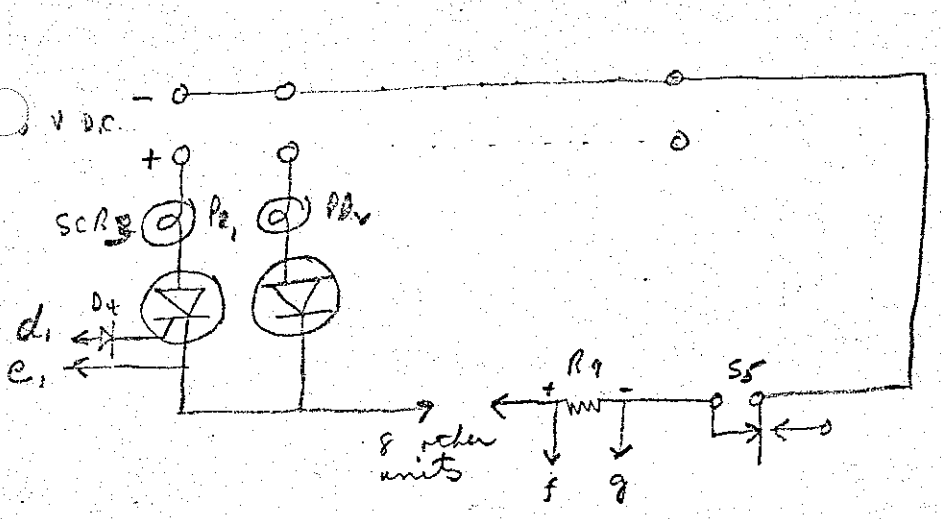
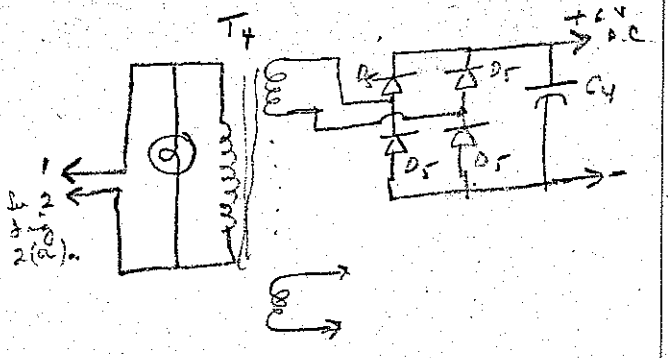


fig 3. Trigger circuit for SCR_1 2.





(b)

fig. 4. (a) Panel lamps circuit.
(b) Power supply for lamps circuit.

fire, relays 2 and 3 are energized and S_6 and S_7 will momentarily open, removing the holding currents from their respective circuits and thus turning off the lamps. The delay time is determined by the time constant of R_{11} and C_8.

To operate the pulser set the variac to the desired voltage with S_3 and S_4 open (max dc = 400V). Close all the S_3 and S_4 switches and allow about four minutes for the capacitors to receive their final charge. If, upon, application of a trigger, all 10 lights turn on, the pulser is operating satisfactorily. If one or more lights do not light up, set M to the unlighted row and observe the meter reading under discharge conditions. If the needle shows only a small dip under discharge conditions, that particular row is not discharging.

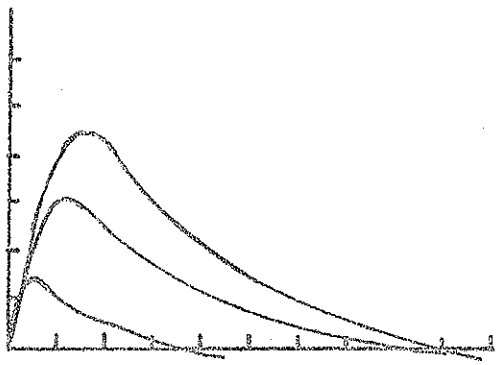


Fig. 6 - Current pulse for 1, 5, and 10 rows

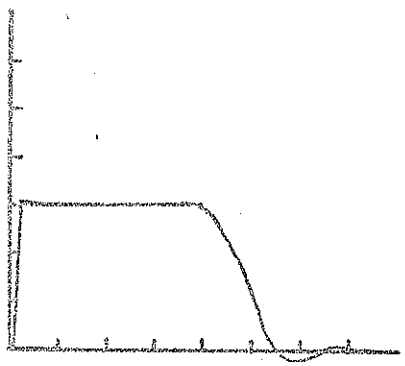


Fig. 7 - SCR 1 trigger pulse.

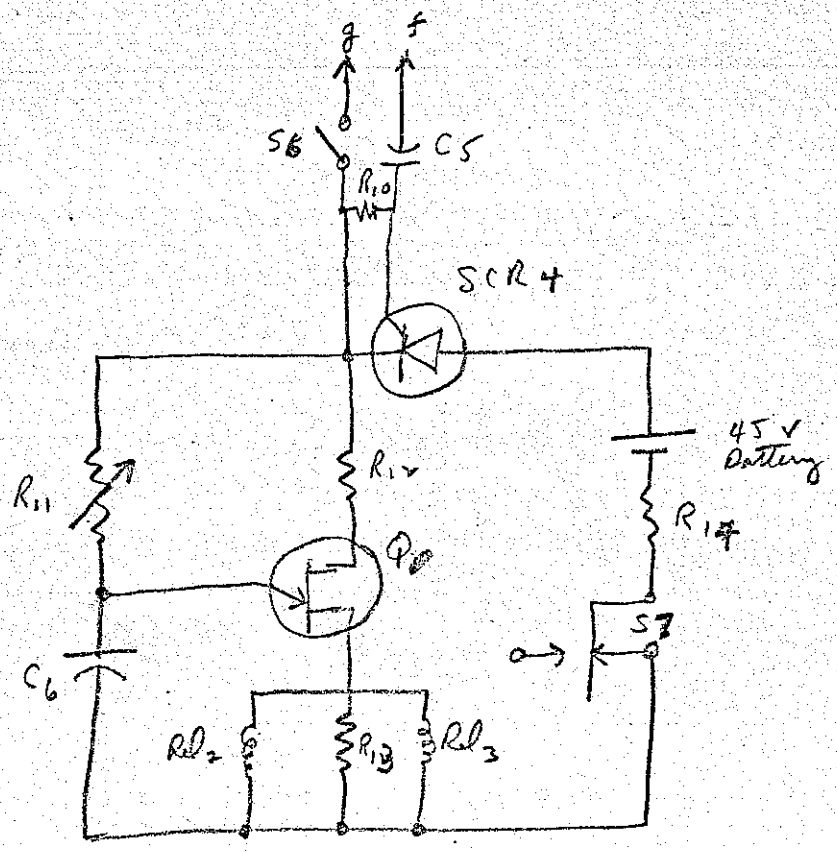


Fig 5. Panel lamp turn-on circuit

PARTS LIST

C	10 x 1200μf, 450V
C_1	0.1, 600V
C_2	1.0μf, 600V
C_3	10μf, 450V
C_4	100μf, 25V
C_5	0.47μf, 35V
C_6	1000μf, 25V
D_1	1N250C
D_2	1N4051R
D_3	1N1084
D_4	1N1521
D_5	1N645
M	50μA
Pl	Number 47
Q_1	2N491
SCR_1	10 C290E - G.E.
SCR_2	C35D - G.E.
SCR_3	2N3528
SCR_4	C106 B1 - G.E.
S_2	10 Pole rotary
S_5	Contacts of Rel.2.
S_7	Contacts of Rel.3.
R_1	250Ω, 200W
R_2	500Ω, 400W
R_3	10 MΩ, 1W
R_4	400Ω, 20W
R_5	10Ω, 20W
R_6	2.5 x 10^{-4}Ω, 50 mV
R_7	10Ω, 10W
R_8	5Ω, 5W
R_{10}	1K, ½W
R_{11}	25K variable
R_{12}	350Ω, ¼W
R_{13}	150Ω, ¼W
R_{14}	1K, ½W
T_1	9T51Y12 - G.E.
T_2	10 100T/200T pulse transformer
T_3	10 secondary, pulse transformer, shop wound
T_4	10 secondaries wound on 6.3V filament transformer
$Rel._1$	110V, 60Hz
$Rel._2$	P&B PW5LS
$Rel._3$	P&B PW5LS