The Multichanel High Current Pulsed Generator with Transformer Coupling Load

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Abstract – Simultaneous switching on or start several high voltage devices is required to provide in some high current electronics applications. The proposed generator simultaneously forms on many load high current or high voltage pulses to switch on power devices. In the generator one key switch on several charged capacitors, each of which is connected to the primary winding of the separate pulsed transformer. The secondary winding of each transformer is connected to its load. Such scheme was used in multi-beams acoustic shock waves generator and in some devices for simultaneous electric explosion of many micro wires. The results of optimization constructive transformer's parameters for two limiting cases – a low-resistance load and high-resistance load are presented. Cable transformers are used in designed six-channel microsecond range generator.

As required simultaneous start several pulsed devices often the direct way is used – the switching element each pulsed device is started from one initiating block. At instability switching on separate switching elements brings time dispersion start of pulsed devices. However, in some cases there is possibility of the independent turning on the pulsed loads in the united scheme with use only one switching element. Such scheme in microsecond range can be made using transformer coupling loads with capacitive storage devices which run down through the general switching element and the primery windings of the transformers.

The proposed scheme for particular case of three resistance loads is shown in Fig. 1.

In this scheme each capacitor C1, … CN is connected to primary winding corresponding pulsed transformer TX1, … TXN. All capacitors switch on by means of the general spark-gap U1. The loads R1, … RN are connected to secondary winding of transformer. When closing spark-gap U1 each capacitor independently runs down through primary winding of the transformer, to which capacitor is connected. As a result the current pulses are formed simultaneously in the loads. Switching on capacitors by means of the one spark-gap provides synchronous excitation of the current in all loads.

For synchronous electric explosion of many micro wires, used in the detonator, the six-channel microsecond range high current generator was made. In this generator six cylindrical capacitors by capacity 0.1 μF each charging before voltage 10 kV are switched on by the general spark-gap device RU-62.

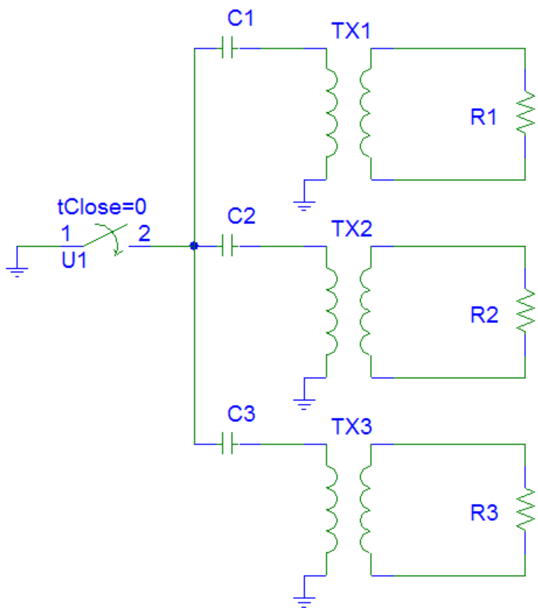

Fig. 1

The capacitors are placed on the forming cylinder generatrix and lower the capacitor's connectors are attaching on metallic disk, but the upper connectors - on dielectric disk. The spark-gap device is mounted on metallic disk in center. The second electrode of spark-gap device is connected to the second metallic disks. The cable lines by length 5–10 m were connected to second metalic disk and to capacitor connectors, mounted on the upper dielectric disk. The second end of each cable line is connected with the primary winding of the corresponding cable transformer, placed nearby loads. As pulsed transformer were used cable transformers, consisting of two wirerope winding by diameter 50 cm, wound by coaxial cables, in which external conductor is executed with breakup and separate wirerope, formed by separate pieces of the external conductor, connected in parallel. The primary windings of these transformer, consisting of two wirerope of the central conductor of the coaxial cable, is connected through the cable to electrodes of spark-gap device and the capacitor, but secondary windings – to the load.

If we neglect the resistance of explosive micro wires compared with inductive resistance of the secondary windings of transformer, that the current in the second counter is defined by the expression

$$i_2 = kNU \Big/ (1 + L_{S2} / L_2) \sqrt{(L_1 (1 - k^2 / (1 + L_{S2} / L_2) + L_{S1}) / C} \,,$$

where k – the coupling coefficient of the transformer windings; N – the ratio of the turn numbers; U – the voltage of the charging the capacitor C; L_1, L_2 – an inductances primary and secondary windings of the transformer; L_{S1}, L_{S2} – the stray inductances primary and secondary counter.

Under $L_{S2}/L_2 \ll 1$ current in secondary circuit is defined only parameter of the primary counter, turn ratio and the coupling coefficient. In enough broad range of the change loads parameters their resistances value relatively little influences upon the discharge of capacitors in primary counters so the currents of the capacitors discharges approximately alike, but the current through the general spark-gap device approximately in n times greater currents in separate primary counters $I \cong nI_1$, where n – a number of channels. At voltage of the capacitor charging 10 kV the current pulse with amplitude around 1 kA and duration about hundreds nanoseconds was generated in explosive micro wires with enough top speed of the current growth that it is provided the simultaneous explosion of detonators.

In the other limiting cases, when resistance of the load was well over inductive resistance second windings and the stray inductance of the secondary counter, for instance gas or vacuum gap between cathode and initiating electrodes in multi-spark devices, at capacitors discharges through the general spark-gap device on all gaps were simultaneously initiated pulses of high voltage, causing simultaneous breakdown in many parallel included spark channels in multi-spark device. In this case they were used separating or raising cable transformers.

Such discharge scheme was used by us in the multi-beams electromagnetic acoustic shock waves generator. Transformers in this case were inductors (acoustic radiators), consisting from the flat spiral coil (the primary winding) and the metallic membrane (the secondary winding), placed on the coil. At discharge of the capacitor by capacity 1–2 μF, charged before voltage 10 kV, in all membranes the current pulses with the amplitudes of a hundreds kA of the microsecond duration were exited.