Particle Accelerators, 1990, Vol. 29, pp. 111–113
Reprints available directly from the publisher
Photocopying permitted by license only

POSSIBILITIES OF INDUCTIVE STORAGE CIRCUITS IN INDUCTION LINACS

BOBYLEV V.I.
Institute for Theoretical and Experimental Physics, Moscow, USSR

Abstract The possibility of multichannel generators with inductive storage circuits for use in induction linacs is being discussed. High voltage separation of the sections of tne common storage circuit is to be fulfilled by cutting in series with these sections special separating transformers loaded by open while storing the energy diodes and cut of during the pulse. Some estimates of the efficiency and expediency of such generators are carried out.

Linear induction accelerators (LIAs) are widely used now due to many positive features. One of them is big quantity of monotype accelerating sections or thoroidal transformers with 1:1 transformation ratio with individual pulse sources [1]. As usual such sources are the thyratron generators with capacitive storage and pulse correction circuit as usual with magnetic transformation of power [2]. The quantity of such generators in modern LIAs may achieve tens or even hundreds of units [3]. The use of such generators does LIAs out of some their advantages. Due to pulse delay and jitter of thyratrons, for example, it is impossible to start normal operation of LIA from the "very first" pulse and so on. One of the possible ways to overcome these disadvantages may be the use of generators with inductive storage circuits and "hard" commutator. Such a generator consists of a storing inductance connected in series with a hard tube and in parallel with the load through a separation circuit. The energy in such generator is being accumulating in magnetic field of the induction coil while the current through it is increasing. The accumulated energy passes into the load after blocking the tube. The amplitude of the current in the load is equal to the "storing" current in the moment of blocking the tube that is the beginning of the pulse in the load. The load voltage is defined by its resistance and without correction circuits is

$$U = U_s \left(1 + \frac{R}{R_s} \right),$$

where: Us - the voltage on the active part of the inductive storage before the moment of blocking the tube, Rs - the active resistance of the inductive storage and R - the resistance of the load.

The voltage of the power source for such a generator is

$$E = U_s + U_t = I \left(R_s + R_t \right),$$

where: Ut - the tube voltage drop uder controlling ihe current I, Rt - the resistance of the tube under tne same conditions. As the value Rs is normally much less tnan the value R (with factor of hundreds) the supply voltage may be taken only a little more than the value Ut. This fact gives the first advantage to such generators: low voltages in the pauses between pulses. high voltages arise at the controlling tubes only during the short pulses of acceleration. The possibility of strict synchronisation of separate generators and steep pulses due to right use of self-inductance of all circuit elements after blocking the controlling tube are the next and very serious advantages.

The tubes capable to control the currents more 1000A and to withstand to voltages 50kV and more are available now [4]. In case of use of such devices the value of inductance required to feed an acceleration section is

$$L = \frac{2W_n}{kI^2},$$

where: Wn - beam energy gain in a section, k - approximate value of the section efficiency. But such decision requires a powerful hard tube for every accelerating section. Free of this negative feature seems to be a device the simplified diagram of which is presented in Figure 1. The current flows through the tube T1, the coils L1 - Ln and also through the diodes D1 - Dn-1. After blocking the tube the common current of all the coils is switched to the separate circuits consisting of dischargers S1 - Sn and through the primary coils of the accelerating sections marked in the figure as R1 - Rn. Synchronously with blocking the tube T1 pulses of voltages to transformers Tr1 - Trn-1 are applied to provide voltages equal to the voltages of the accelerating sections but of the reverse polarity.

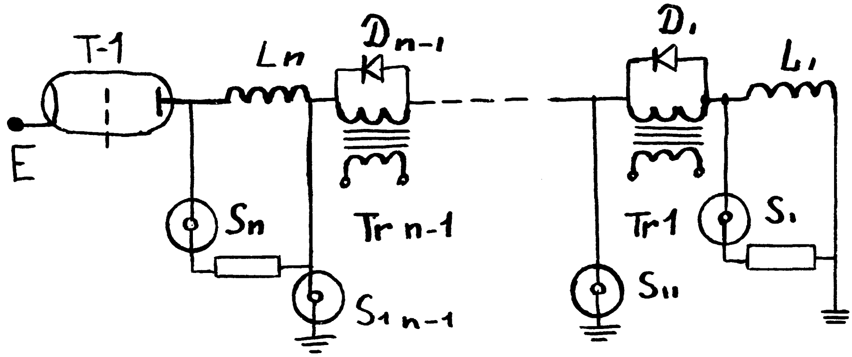

FIGURE 1. Multichannel generator with inductive storage circuit.

This allows to conserve the potential of dischargers S11 - S1n-1 close to zero voltage. These dischargers fire if there occur some dismatching of different accelerating sections. Such kind of storage circuits allows also to use symmetrical feeding of primary coils of the sections to reduce voltages at the tails. The perspectivity of the generators of such type should be especially noted in connection with last successes in high temperature superconductivity.

In conclusion it should be noted that in such parameters as steepness of the pulse, reliability, weight, dimensions, feeding voltages the generators with inductive storage circuits have serious adventages and the recent low power experiments give confidence that they have possibility to be widely used in acceleration technics.

REFERENCES

1. R.J. Briggs, Linear Induction Accelerators, LLNL, USA Nat. Particle Accel. Conf. 1987, USA.
2. Meerovich L.A., Magnetic Pulse Generators, Moscow, Sov. Radio, 1968.
3. L.Reginato, The Advanced Test Accelerator, 50MeV, 10kA Induction Linac, The XV USA Nat. Sonf. on Linear Accelerators, 1986.
4. Bobylev V.I., Raskopin A.M., Powerful Modulator Tube Operation with Peak Pulse Duration, ITEP, Moscow, 1976.