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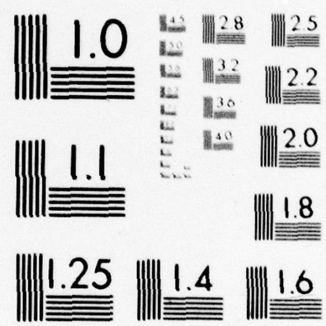
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GENERATOR OF CURRENT PULSES WITH AN AMPLITUDE OF 10^6 A AND STABILITY OF $\pm 10^{-3}$ AT A REPETITION RATE OF 2 Hz*

by

B. F. Bayanov, A. V. Il'in, et al.

EDITED TRANSLATION

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By: B. F. Bayanov, A. V. Il'in, et al.

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А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

0110

GENERATOR OF CURRENT PULSES WITH AN AMPLITUDE OF 10^{4} A AND STABILITY OF $\pm 10^{-3}$ AT A REPETITION RATE OF 2 Hz*

B. F. Bayanov, A. V. Il'in, V. N. Pakin, A. P. Panov, and G. I. Sil'vestrov (Institute of Nuclear Physics of the Siberian Branch [SO] of the Academy of Sciences [AS] USSR)

The generation strong magnetic fields, as well as the use of pulsed systems in acceleration equipment, often leads to the problem of creating powerful generators which operate on an inductive load. Furthermore, experimental conditions sometimes place limitations on the duration and shape of the current pulse and the stability of the current amplitude, as well as requiring high operational reliability.

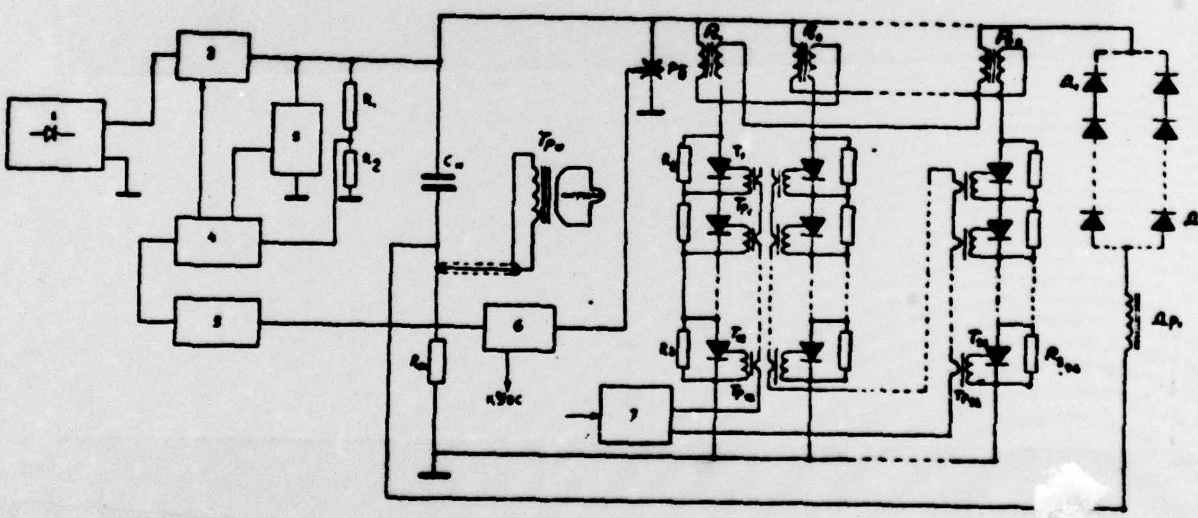
This study considers a generator operating on an inductive load of 0.1 μH created at the IYaF (Institute of Nuclear Physics) of the

SO AS USSR, which provides a sinusoidal unipolar current pulse with a base length of 1.2 μs, an amplitude of 10^6 amperes, and which is stable with precision of ±0.1o/o at a repetition rate of several Hertz.

Direct switching of the pulse current to the load circuit cannot be used in the case in question because there are no gates for these currents. In this case, a *pulse matching transformer* is used in combination with a high-voltage switching gate on a current of dozens of kiloamps.

The generator (Fig. 1 shows a diagram of the generator) consists of capacitive store C_H, which is charged through controllable gate T_1-T_{96} to the primary winding of the pulse transformer (Tp_H). The capacitor is recharged through a special recharging coil (Dr_1) and recharging diodes (D_1-D_{40}) in order to recover the energy.

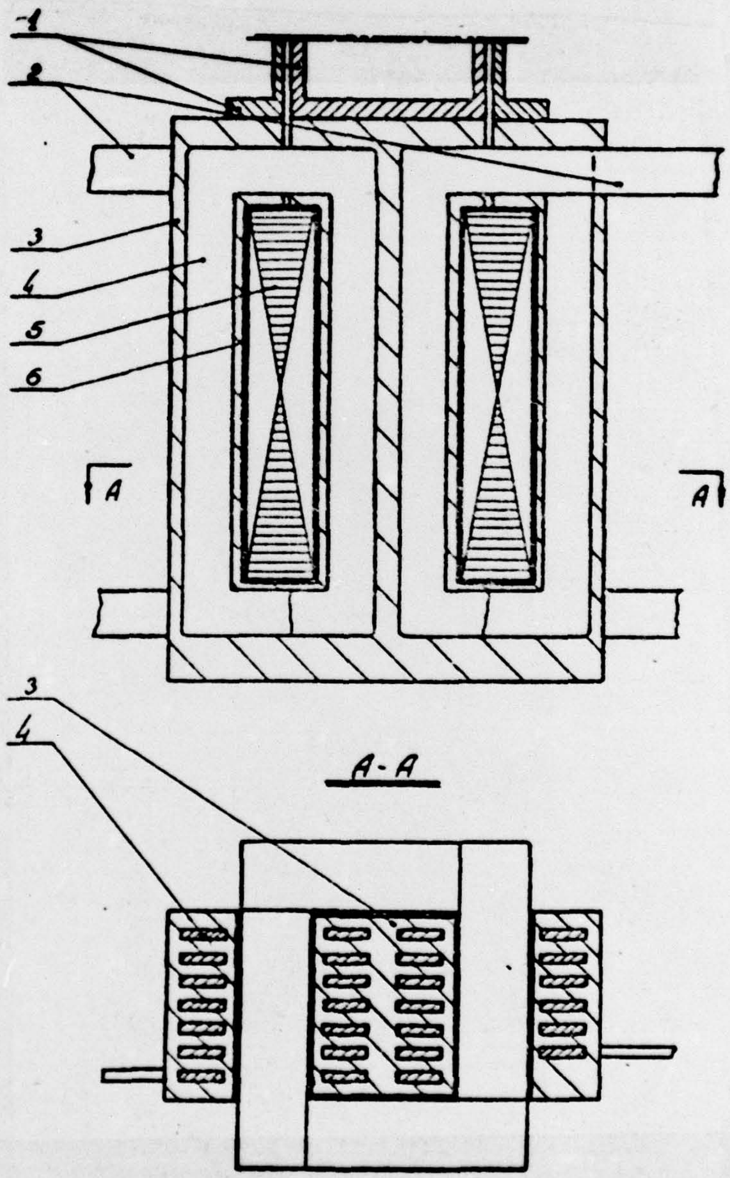
Fig. 1. Diagram of generator. 1 - rectifier, 2 - charging device, 3 - discharge circuit, 4 -comparison circuit, 5 - parameter regulation circuit, 6- thyristor protection circuit, 7 - starting generator, C_H - capacitive store, Tp_H - pulse matching transformer, T_1-T_{96} - switching gates, Re_1-Re_8 - anode reactance coils, D_1-D_{40} - recharging diodes, Dr_1 - recharging coil, $R_{Д1}$-$R_{Д96}$ - divider. KEY: (a) Load. (b) to UVS.



It suffices to regulate the voltage on the capacitive store in order to obtain short-term current amplitude stabilization (as experience shows). In this case, we used the method of voltage regulation by discharging a portion of the charge over a special discharge circuit (3), which is controlled from the comparison circuit (4) [1]. The parameters of this generator drift gradually through time due to the large dynamic and thermal loads in the circuit. Therefore, a circuit for automatically regulating the current amplitude (5) by smoothly varying the level of the regulated voltage on the capacitor is provided to balance these drifts.

The matching transformer (T_{P_M}) is constructed according to the "cable" principle [2]. In order to decrease the transformer's resistance losses and stray inductances, it is made in the form of a three-dimensional secondary coil 3. The primary winding, which consists of wide flat coils 4, is placed in the closed groove of this coil (Fig. 2). This design provides complete coupling of the secondary winding current with the primary, while the stray currents of the individual primary turns are not coupled with each other. This makes the stray inductance proportional to the first degree of the number of turns. Here the turns of the primary winding are dynamically balanced. They are insulated from the secondary coil by Epostek insulation four mm thick on a voltage of 20 kV. The transformation coefficient is 40. The stray inductance is $8 \cdot 10^{-9}$ H. The cross section of the magnetic circuit is 5x600 cm^2, while the range of inductance in iron at a current of 10^6 A is 15 kgauss.

Fig. 2. Pulse transformer. 1 - low-inductance tap of secondary winding, lead of primary winding, 3 - three-dimensional coil of secondary winding, 4 - coil of primary winding, 5 - magnetic circuit, 6 - magnetic circuit insulation.



The main problem in creating the generator consisted of developing a 25 kA switching gate at a voltage of 10 kV and pulse length on the order of one ms. We avoided the mercury rectifiers which are ordinarily used in this type of circuit due to their bulkiness and the complexity of their operation.

Two types of gates were developed for this generator. The diagram in Fig. 1 shows the first version. It is constructed with thyristors, which are small, do not require filament circuits, are not sensitive to changes in external temperature, and have a long service life.

Studies conducted on thyristors in the short pulse switching mode showed that UPAKL-150 or VKDU-150 thyristors can switch currents of up to five kA at a sinusoidal pulse length on the order of one ms. Under these conditions, the thyristors withstand several million pulses without exhibiting an appreciable change in their parameters. A system in which on the order of three kA passes through each thyristor was selected in the generator's working circuit in order to provide reliability.

The generator's switching gate consists of eight parallel branches with 12 series-connected VKDU-150-7 thyristors in each branch. Resistors ($R_{A1}-R_{A96}$) are connected in parallel to each thyristor in order to balance the potentials, while each branch is connected to a common point in the circuit through coupled anode reactances (Re_1-Re_8), which distribute the currents over the branches with precision down to 10o/o. The thyristors are controlled from one starting generator (7) through pulse transformers (Tr_1-Tr_{96}). The primary winding is a single wire with high-voltage insulation (magneto) which passes successively through the magnetic circuits of all of the transformers.

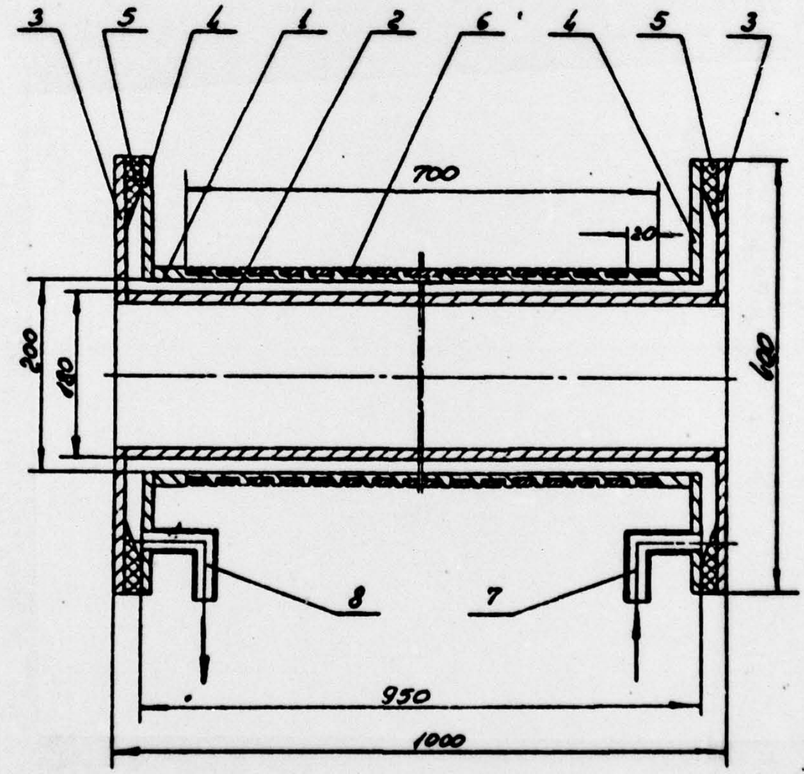
One feature of the thyristors' operation is that separate overloads with an amplitude above six kA and a current build-up rate of more than 20 A/μs can cause individual thyristors or entire series-connected branches to completely break down. This makes it necessary to provide special protection for the thyristors. A blocking tube ($R_{б}$) with solid insulation was developed for this purpose. When the electronic protection circuit (6) operates in response to the amplitude and the current derivative, explosive breakdown occurs and the tube shorts out the entire commutator in several μs, thereby keeping the thyristors from being destroyed. This circuit also cuts off the generator power through the UBS system.

The capacitive store is recharged through a coil (Dr_1) and through four parallel branches consisting of ten series-connected

VKDL-200-9 diodes each (D_1-D_{40}). The recharging pulse lasts ten ms at an amplitude of 2.6 kA.

A gas-discharge gate controlled by a pulsed magnetic field (Fig. 3) was developed as the second version.

Fig. 3. Design of discharger. 1 - cathode, 2 - anode, 3 - end disks of anode, 4 - end disks of cathode, 5 - insulation, 6 - control **winding, 7 - admission pipe, 8 - exhaust pipe.**

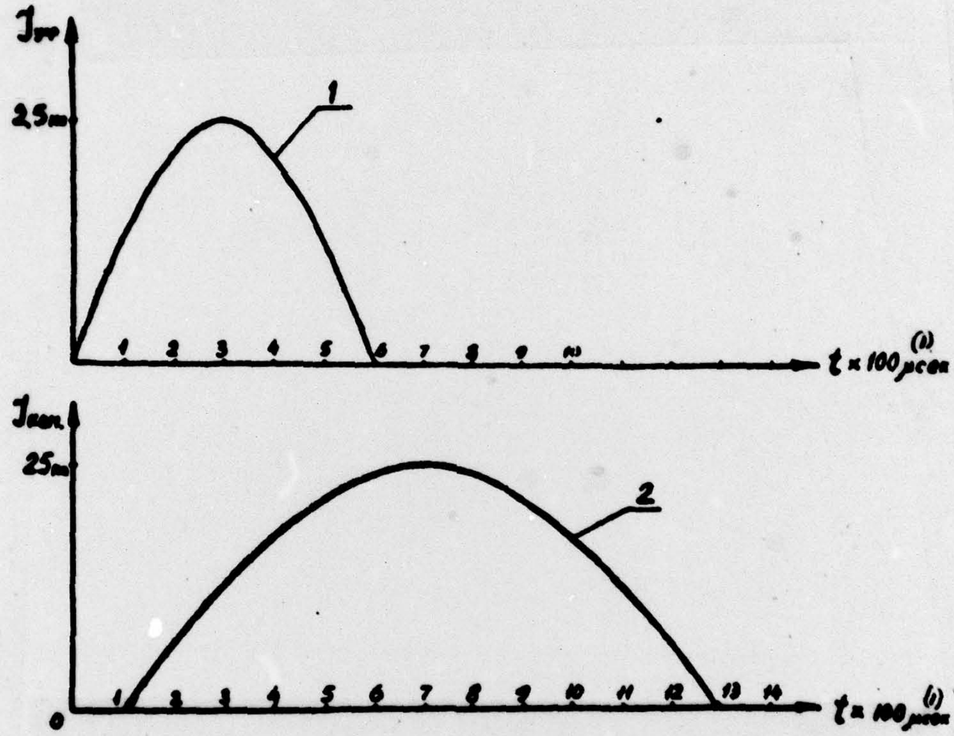


The cathode 1 and anode 2 are made of stainless steel in the form of two coaxial cylinders which turn into disks 3 and 4 at the ends; these disks are insulated from each other. The conducting cables are symmetrically attached to these disks. A helical groove is made in the external tube - the cathode. Winding 6 made of copper bus 2x10 mm^2 is double-wound into this groove, forming the magnetic field in the working gap.

The maximum value of the field is near the cathode, while it drops rapidly in the direction toward the anode. Both its value and sign vary with the winding spacing frequency in the axial direction along the cathode.

The stainless steel wall of the cathode is one mm thick; therefore, the skin effect plays a very small part, while the intermittent field between the anode and the cathode virtually duplicates the form of the pulse current in the control winding through time in the 1000 μs - 2 ms range (see Fig. 4).

Fig. 4. Time diagrams. 1 - discharger control current, 2 - current switched through discharger. KEY: (1) ms.



The gate operates in the pressure range of $3 \cdot 10^{-3}$ - $6 \cdot 10^{-3}$ mm Hg in air and argon with an anode-cathode gap of one cm and an amplitude of the intermittent field on the surface of the cathode of 500 Oe.

This method of control provides good gating properties and a uniform distribution of the discharge over the entire surface of the electrodes under the control winding. The gate operates reliably under conditions of 25 kA and 10 kV for one ms.

The generator has successfully withstood 10^5 pulses under these conditions and is continuing to function reliably.

Bibliography

1. Б.Ф. Баянов, А.В. Ильин, В.Н. Пакин, А.П. Панов, Г.И. Сильвестров "Генератор импульсного тока" Препринт ИЯФ СО АН СССР № 85, 1966.

2. В.Р. Карасик ПТЭ, 1962, № 6, стр. 5.

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