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BAKED OXIDE CATHODE ON A NICKEL BASE. II,(U)

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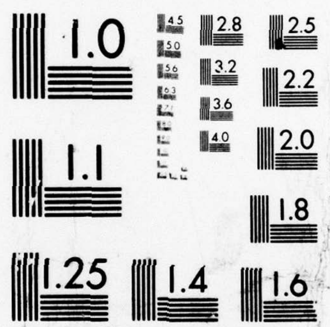

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BAKED OXIDE CATHODE ON A NICKEL BASE. II

By

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FOREIGN TECHNOLOGY DIVISION

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EDITED TRANSLATION

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А а	*А а*	A, a	Р р	*Р р*	R, r
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Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
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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

BAKED OXIDE CATHODE ON A NICKEL BASE. II

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It is a known fact that the emission properties, electrical strength, and durability of a cathode are determined not only by the operating temperature and vacuum but also by the structure of both the nickel-carbonate coating before the heat treatment and by the nickel-oxide coating after the heat treatment of the cathode. On the basis of an analysis of the structure of a sintered cathode with a nickel-carbonate coating (33.4% nickel powder and 66.6% of binary carbonate) it was established that, when baked in hydrogen furnaces, nickel sponge bakes poorly to the core; the nickel grain bonding in the sponge is weak; the nickel-oxide coating in the tube is rough and loose after the heat treatment; the bond between the oxide grains and the nickel powder grains and between the nickel-oxide coating and the sponge is weak; the nickel powder grains in the nickel-oxide coating do not represent a uniquely bonded conductor, but are in it in the form of isolated, well-conducting micro-areas. With such a structure of the nickel-oxide coating of the cathode, there can be no formation of a continuous nickel grid on the surface of the cathode which would shield the active components of the cathode from an electrical field, which is necessary for the tube cathodes with a high gradient of the electrical field.

In a sintered cathode with a nickel-oxide paste rubbed into the sponge (Fig. a) the nickel-oxide coating is in the pores and the edges of the pores are the cell of the lattice which shields the active coating. However, the larger the pore the poorer the shielding. Consequently, there can occur individual regions on the cathode surface that do not have a reliable electrical shielding. Furthermore, in such a cathode, the reserves of active emitting substances are very limited; for this reason, the guaranteed service life of the tubes with this type of a cathode does not exceed 250 h. With an increase in the reserve of the emitting components of the cathode by the deposition of additional layers of the nickel-carbonate coating onto the sponge, the electrical strength decreases due to the absence of the shielding surface of the grid in such a cathode (Fig. b). The studies carried out on the structure of the experimental baked cathodes have shown that, after the heat treatment of the cathode in the tube (table), the cathode has a structure shown in the Figure, c: after baking the nickel powder of the nickel-oxide coating together with the sponge forms a finely porous structure (the size of pores is not over 300 μm) in the form of a solid grid.

There is a good cohesion between the nickel coating and sponge. The nickel-oxide coating represents a baked nickel matrix with fine pores which contain the oxide grains in a mixture with the nickel grains.

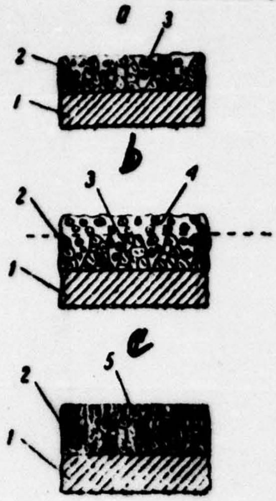
After the heat treatment the surface of a baked cathode is smooth, which decreases the electrical field gradient at the cathode considerably, thereby increasing its electrical strength. At the cathode temperature of 950°C the current pulse density in the baked cathodes, as well as in sintered, is equal to 2 A/cm^2 with a drop in voltage on the anode to 4.5 kV, while at 850°C it is equal to 1.8 A/cm^2 with a drop in voltage on the anode to 4.4 kV. During the measurement of the pulsed emission current the pulse duration was 0.7–1.3 μs. All tubes with baked cathodes withstood the breakdown tests at the intensity of 70 kV/cm, whereas in the series-produced tubes with sintered cathodes, cases of breakdown were observed with an intensity at the cathode of 50 kV/cm.

The experimental tubes with baked cathodes were tested for durability. One tube was tested at T_k=950$\pm$20°C under the following conditions: the pulsed current of the anode was 100 A, drop in voltage on the anode U_{an}=4.4 kV, reversed pulsed voltage on the anode U_{ai}=56 kV, pulse duration - 4 μs, and duty factor - 875. After 500 h of operation at an increased gradient of strength of the electrical field at 80 kV/cm, there were no breakdowns, while the drop in voltage on the anode was 4.4 kV (when I_{ai} =100 A). i. e., the emissive capability of the cathode remained the same. Eleven experimental tubes were tested with the cathode temperature at 850±20°C under the following conditions: U_{an} =4.4 kV when I_a =100 A and U_{ai} =50 kV with the same duration of the pulse and the duty factor as in the case of the first tube. After 500 h of operation the parameters of three tubes remained virtually unchanged (table, first group of tubes).

Seven experimental tubes with baked cathodes were tested in an operational installation of the user. Four of them stayed in operation for over 500 h (second group of tubes). Thus, the electrical parameters of the tubes with baked cathodes did not change significantly. Three tubes were tested for a longer period of time (third group of tubes). The breakdown test at U_{ai} =50 kV showed that all eleven tubes proved to be usable.

After the high-voltage kenotrons operated for over 2400 h in a functional installation, the drop in voltage on the anode did not exceed 4.6 kV, whereas the drop in voltage on the series-produced tubes reaches 6 kV. When these tubes were tested for a breakdown, there were none and there was no sparking, while the series-produced tubes often failed after the operation of only 100 h (the age limit - 250 h). The most frequent cause of failure was due to the breakdown of the cathode-anode gap.

Thus, the experiments have shown that the baked oxide cathodes on a nickel base are a little more complex than the sintered cathodes with regard to construction but considerably simpler than the all-baked, while with regard to the electrical parameters, they exceed the sintered cathodes and do not yield to the all-baked cathodes. In their mechanical properties they are better than the sintered and all-baked cathodes, have good electrical strength, and long service life.



Structure of a sintered cathode (a), sintered cathode with an additional layer of the nickel-oxide coating (b); structure of a baked cathode (c):

1 - cathode core; 2 - sponge; 3 - nickel-oxide coating; 4 - baked nickel-oxide coating.

Table

1) Номер лампы	2) Срок службы, час.	3) Параметры	
		4) $I_н$, а, при $U_н$ = 13,6 в	5) $U_{ан}$, кв, при $I_а$ = 100 а
6) Первая группа ламп			
2	— 500	33 33	4,1 4,1
3	— 550	34 34	4,4 4,4
4	— 500	33 33	4,3 4,3
7) Вторая группа ламп			
5	— 582	33 33	4,4 4,4
6	— 567	33,5 33,5	4,3 4,3
7	— 551	33 33	4,4 4,42
8	— 582	33 33	4,3 4,4
8) Третья группа ламп			
9	— 2444	32,5 32,0	4,2 4,5
10	— 3326	32,5 32,0	4,3 4,45
11	— 2556	33,5 33,5	4,3 4,6

KEY: (1) Tube number (2) Period of operation, h (3) Parameters (4) A, when ... V (5) kV, when... A (6) First group of tubes (7) Second group of tubes (8) Third group of tubes

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