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# FOREIGN TECHNOLOGY DIVISION

CHARGED PARTICLE ACCELERATOR

By

Ye. A. Abramyan, B. M. Lagunov, et al

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# EDITED TRANSLATION

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CHARGED PARTICLE ACCELERATOR

By: Ye. A. Abramyan, B. M. Lagunov, et al

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## U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

| Block | Italic | Transliteration | Block | Italic | Transliteration |
|---|---|---|---|---|---|
| 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 | $\operatorname{sech}^{-1}$ |
| cosec | csc | csch | csch | arc csch | $\operatorname{csch}^{-1}$ |

| Russian | English |
|---|---|
| rot | curl |
| lg | log |

# CHARGED PARTICLE ACCELERATOR

Ye. A. Abramyan, B. M. Lagunov, A. G. Ponomarenko,
and R. I. Soloukhin (authors)
Institute of Nuclear Physics, SO AS USSR (applicant)

The invention pertains to devices for the acceleration of intense fluxes of charged particles.

Heavy-current accelerators are known which contain a pulse transformer as the charging device. Here the electrical energy storing device is a forming line with a low value of wave resistance. High-voltage isolation is realized with the help of water, which has a high value of dielectric permeability.

The electrical strength of water depends on the time of application of voltage and has a value of 40-50 kW/mm at a pulse duration of 0.2-0.5 μs.

The pulse transformer ensures relatively simply a charging time for a storage device with water insulation of an order of 15 μs. A lowering of the charging time to 1 μs and less leads to serious technical difficulties (use of a low-inductance capacitor bank with high initial voltages; the requirements for isolation of the transformer are raised significantly).

On the other hand, the low value of specific resistance of water leads to a significant leakage of electrical energy during

the discharging of the storage device through the water, especially when the charging time of the storage device is comparable with the time of its discharging through a natural dielectric, in this case the efficiency can be lowered to 60-80%.

Thus the use of the known accelerator is connected with the following shortcomings: the low value of electrical strength of water with a charging time for the storage device of an order of 15 μs and more; a lowering of efficiency due to the high conductivity of water.

The purpose of the proposed invention is the elimination of these shortcomings.

An increase of water pressure leads to an increase of its electrical strength; an increase in the specific resistance of pure water with a lowering of temperature is preserved also at high pressure. Calculation shows that a lowering of water temperature to 0°C makes it possible to raise the efficiency to 93-95% with preservation of a pulse duration of 15 μs.

The proposed heavy-current accelerator of charged particles contains a pulse transformer, a shaping storage line, situated in water, a commutating discharger, and an acceleration tube.

For increasing the electrical strength a pressure of 30-50 atm and higher is created in the water.

For reducing the leakage of energy during the discharging of the storage device through the water it is cooled to a temperature close to 0°C.

Figure 1 shows the construction of a charged particle accelerator on 2 MeV; Figure 2 is the electricl schematic of the accelerator.

Housing 1 is made out of stainless steel with a thickness of 2 cm. Inside the housing in water 2, serving as the insulating medium, there is a pulse transformer of the Tesla type (the primary 3 and secondary 4 coils are shown), and a cylindrical potential electrode 5, forming, together with the inner wall of the housing, a coaxial shaping line with a length of 1 mm and a working gap of around 7 cm. The line has a capacitance of 0.015 μF, a

wave resistance of 2 ohms, and an operating voltage of up to 2 MV.

For the purpose of reducing the energy of the shock wave, developing during the electrical breakdown in the medium, the commutating discharger 6 functions in a gas under pressure.

The accelerating tube contains an insulator 7 and an automatically controlled cathode 8.

A pressure of 30-50 atm in the water is created with the help of the gas cavity 9, which has a flexible wall, made out of polyethylene film for example. The construction is such that the pressures in the gas cavity 9, in the discharger chamber 6, and in the water 2 are the same. Here it is possible to separate the gas chamber of the discharger 6 from the water 2 by a thin wall 10.

For extinguishing the hydraulic shock wave, which develops in the case of an accidental breakdown, openings 11 are made in the potential electrode 5.

The water, used as the insulator, is filtered by a filter down to 1 μm, is evacuated and is desalinized by ion-exchange resins to a specific resistance of an order of $10^7$ ohm cm.

Then the water is cooled to 1-2°C. Heat-insulating lining 12 serves for maintaining the low temperature of the water.

The electrical circuit has the following parameters.

From capacitor bank $C_1$ through the commutating discharger $P_1$ with the help of pulse transformer $L_1$, $L_2$ the shaping line $C_2$ is charged to 2 MV. The voltage of the primary capacitor bank $C_1$ is equal to 100 kV, capacitance 7.5 μF. The time for charging of the line is 10-15 μs. The total amount of energy, stored in the shaping line $C_2$ at 2 MV, is equal to 30 kJ. At the maximum of voltage on the line the commutating discharger 13 is broken through and a negative voltage is applied to the autoelectronic cathode 14. The low internal resistance of the line (2 ohms) makes it possible to obtain an electron current of an order of 300-500 kA with an electron energy up to 1 MeV.

As a result of an increase of water pressure and a lowering of its temperature it is possible to lengthen the time of charging of the shaping line $C_2$ and thus simplify significantly the capacitor

bank $C_1$, in which the energy is stored before the beginning of the working cycle. In the case of short times the use of low-inductive capacitors, their careful installation, and several parallel synchronously functioning dischargers are required.

## Subject of Invention

1. An accelerator of charged particles, containing a high-voltage pulse transformer, an electrical shaping line, situated in a reservoir with a dielectric fluid, and an accelerating tube, characterized by the fact that for the purpose of increasing the electrical strength of the transformer and the line, the reservoir for the dielectric fluid is equipped with a device for maintaining a high pressure (30-50 atm) in the liquid and a thermostat for maintaining the temperature of the liquid close to $0^{\circ}C$.

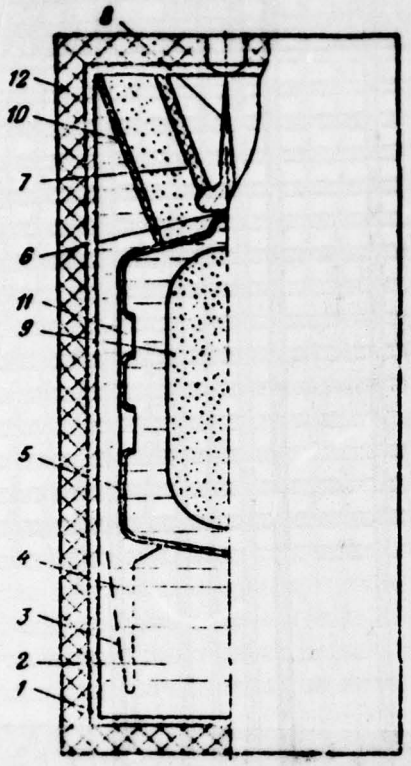


Figure 1.

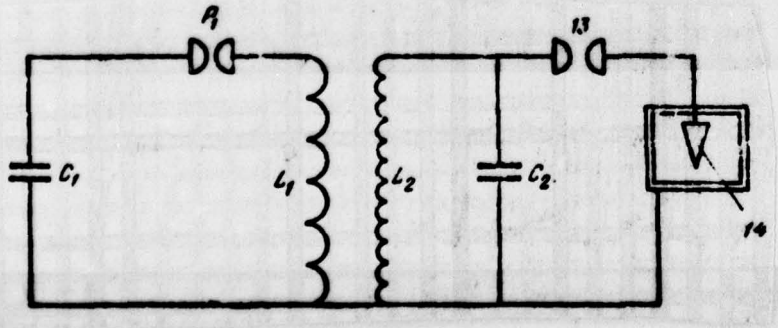


Figure 2.

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