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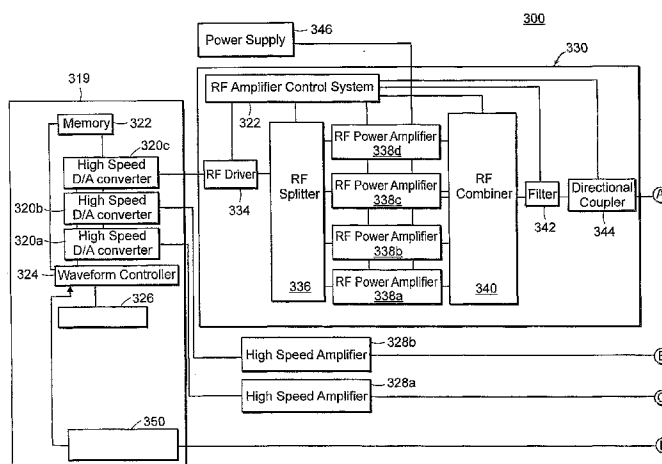
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(54) Title: A PROGRAMMABLE RADIO FREQUENCY WAVEFORM GENERATOR FOR A SYNCHROCYCLOTRON



(57) Abstract: A synchrocyclotron comprises a resonant circuit that includes electrodes having a gap therebetween across the magnetic field. An oscillating voltage input, having a variable amplitude and frequency determined by a programmable digital waveform generator generates an oscillating electric field across the gap. The synchrocyclotron can include a variable capacitor in circuit with the electrodes to vary the resonant frequency. The synchrocyclotron can further include an injection electrode and an extraction electrode having voltages controlled by the programmable digital waveform generator. The synchrocyclotron can further include a beam monitor. The synchrocyclotron can detect resonant conditions in the resonant circuit by measuring the voltage and or current in the resonant circuit, driven by the input voltage, and adjust the capacitance of the variable capacitor or the frequency of the input voltage to maintain the resonant conditions. The programmable waveform generator can adjust at least one of the oscillating voltage input, the voltage on the injection electrode and the voltage on the extraction electrode according to beam intensity and in response to changes in resonant conditions.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
INV. H05H13/02 H05H7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of Box C.

See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SCHNEIDER R ET AL: "Nevis synchrocyclotron conversion program-r.f. system" IEEE TRANSACTIONS ON NUCLEAR SCIENCE USA, vol. ns16, no. 3, June 1969 (1969-06), pages 430-433, XP002402010 ISSN: 0018-9499	1-6, 16, 18, 20-28, 32, 33, 35, 37-43, 50, 54, 55, 57-60, 69, 70
Y	figures 1,2 page 430, column 2, lines 11-19 page 430, column 1, lines 52-54	
X	----- US 4 641 057 A (BLOSSER HENRY G [US] ET AL) 3 February 1987 (1987-02-03)	7-15, 17, 19, 29-31, 34, 36, 44-49, 61-64, 71-74
Y	column 2, lines 7-13, 53-57; figures 1, 2 column 3, lines 61-68	
Y	column 3, lines 49-52 column 2, lines 49-52; figure 1	7-9, 51, 53, 68, 71-74
Y	ENCHEVICH AND TOMILINA: ATOMIC ENERGY TRANSLATED FROM ATOMNAYA ENERGIYA, vol. 26, no. 3, 1969, - 1969 pages 315-316, XP008069829	10-14, 17, 29-31, 34, 44-48, 51, 61-64, 71-74
A	page 316, lines 17, 18; figure 1B) ----- ALLARDYCE B W ET AL: "Performance and prospects of the reconstructed CERN 600 MeV synchro-cyclotron" IEEE TRANSACTIONS ON NUCLEAR SCIENCE USA, vol. ns-24, no. 3, June 1977 (1977-06), pages 1631-1633, XP002402645 ISSN: 0018-9499 page 1632; tables II, col. 6 ----- -/--	13, 29, 32

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BLOSSER H G: "Synchrocyclotron improvement programs" IEEE TRANSACTIONS ON NUCLEAR SCIENCE USA, vol. ns16, no. 3, June 1969 (1969-06), pages 405-414, XP002402707 ISSN: 0018-9499 page 411, column 1, lines 59-65 -----	15,19, 36,49, 53,68
A	BLOSSER H G: "Compact superconducting synchrocyclotron systems for proton therapy" NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH, SECTION B (BEAM INTERACTIONS WITH MATERIALS AND ATOMS) NETHERLANDS, vol. B40-41, April 1989 (1989-04), pages 1326-1330, XP002402708 ISSN: 0168-583X the whole document -----	1,20,37, 54,69
A	LECROY W ET AL: "Viewing probe for high voltage pulses" REVIEW OF SCIENTIFIC INSTRUMENTS USA, vol. 31, no. 12, December 1960 (1960-12), page 1354, XP002402837 the whole document -----	7,16,26, 33,41, 50,65,74

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4641057	A	NONE	
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