(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 386 242 A1**

(12) # EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC

(21) Application number: **88909404.1**

(22) Date of filing: **19.08.88**

(86) International application number: **PCT/SU88/00157**

(87) International publication number: **WO 90/01991 (08.03.90 90/06)**

(51) Int. Cl.[5]: **B03C 3/68, B03C 3/38**

(43) Date of publication of application: **12.09.90 Bulletin 90/37**

(84) Designated Contracting States: **CH DE FR GB LI SE**

(71) Applicant: **GOSUDARSTVENNY NAUCHNO-ISSLEDOVATELSKY ENERGETICHESKY INSTITUT IMENI G.M.KRZHIZHANOVSKOGO**
Leninsky pr., 19
Moscow, 117921(SU)

(72) Inventor: **ZHMUROV, Valery Pavlovich**
ul. Narodnogo Opolchenia, 25-63
Moscow, 123154(SU)
Inventor: **GRINSHTEIN, Boris Iliich**
ul. Ostrovityanova, 16-4-134
Moscow, 117321(SU)
Inventor: **SHVARTS, Zinovy Lazarevich**
1 mikroraion, 14-76 Yaroslavskaya obl.
Rostov, 152101(SU)
Inventor: **NAGORNY, Viktor Vladimirovich**
ul. Mayakovskogo, 14-132 Moskovskaya obl.
Khimki, 141100(SU)
Inventor: **BEZUGLY, Stanislav Leontievich**
ul. Ivanovskaya, 4-9
Zaporozhie, 330041(SU)
Inventor: **KOTLYAR, Vladimir Petrovich**
ul. Kiyazhko, 38-54
Zaporozhie, 330065(SU)
Inventor: **SIKORSKY, Vladimir Ivanovich**
ul. Vidova, 168-34
Novorossiisk, 630000(SU)

(74) Representative: **Crawford, Andrew Birkby et al**
A.A. THORNTON & CO. Northumberland House 303-306 High Holborn
London WC1V 7LE(GB)

(54) **PULSED-VOLTAGE SOURCE FOR GAS-CLEANING ELECTROFILTERS.**

EP 0 386 242 A1

(57) Pulsed-voltage source for gas-cleaning electrofilters comprising a step-up transformer (5), whose primary winding (4) is connected, through a thyristor regulator (1), to a sinusoidal voltage source. To the controlling inputs (17) of the thyristor regulator (1) is connected the output of a control unit (16), the input of which is connected to a transmitter (26) of electric parameters of the gas-cleaning electrofilter. The transmitter (26) is connected to the corona and receiving electrodes (12, 14) of the electrofiltor (13). The source comprises a rectifying bridge (7) whose inputs are connected to the secondary winding (6) of the step-up transformer (5), whereas the first and the second outputs are connected to the electrodes (12, 14) of the electrofilter (13), as well as a capacitor (18), the first input of which is connected, through a choke coil (19) and an electronic switch (20) interconnected in series, to the corona electrode (12) of the electrofilter (13), whereas the second output is connected to the receiving electrode (14) of the electrofilter (13). The electronic switch (20) is shunted by an oppositely connected rectifier (21). The output power contact (23) and the controlling input (24) of the electronic switch (20) are connected to a pulse generator (25).

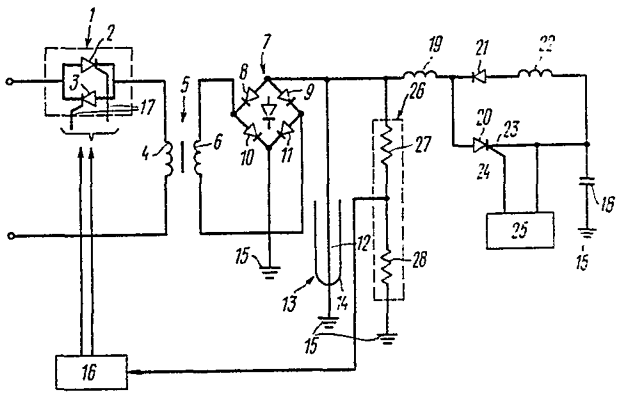

FIG. 1

PULSE VOLTAGE SUPPLY FOR ELECTROSTATIC PRECIPITATORS

Field of the Invention

The invention relates to the area of electric gas cleaning, and more specifically to pulse voltage supplies for electrostatic precipitators.

Prior Art

Widely known in the art is a pulse voltage supply for electrostatic precipitators (K.Porle et al. International Conference on Electrostatic Precipitation, No. 12-15, 1984, Kyoto, Japan, p.77), comprising a thyristor controller connected to a sine voltage supply, a step-up transformer, the primary whereof is connected to the thyristor controller, with a voltage sensor connected to the corona-forming and precipitating electrodes. The output of the voltage sensor is connected to the input of a control unit, the outputs whereof are connected to the thyristor gates in the thyristor controller. The secondary of the step-up transformer drives a bridge rectifier, the output whereof is loaded onto a capacitor, the first lead whereof is connected to the precipitator's corona-forming electrode via connected in series electronic key and first choke, with the electronic key shunted by connected in series gate of opposite polarity and second choke. The second lead of the capacitor is connected to the precipitating electrode. The outputs of a pulse generator are connected to the heavy-duty terminal and to the control input of the electronic key.

The repetition rate of pulses from the generator connected to the heavy-duty terminal and to the control input of the electronic key is preset for each gas cleaning process individually, depending on the properties of the dust being precepitated. The pulse supply further comprises a resistor with the first lead thereof connected to the output of the bridge rectifier and with the second lead thereof connected to a lead of the first choke connected to the electronic key.

At an enabled electronic key the voltage across the precipitator electrodes is approximately equal to the voltage of corona discharge initiation.

The capacitor connected across the bridge rectifier output is charged to a voltage, the magnitude whereof is set by the thyristor controller, which receives a signal, as specified by the precipitator process, from the output of the control unit. Enabling the electronic key initiates an oscillatory process in the capacitor precipitator-choke network, wherein the time dependence of the voltage across the precipitator electrodes is determined by the precipitator and choke electric parameters, so that this voltage exceeds the voltage across the capacitor. As a result, a bell-shaped pulse is developed across the precipitator. After the electronic key is disabled the voltage across the electrodes drops off to the corona voltage. This bell-shaped waveform of the supply voltage eliminates corona backfiring, liable to be generated when precipitating dust of a specific electric conductivity over 10^{10} Ohm·m (high-resistance dust). However, a pulse supply voltage reduces the mean voltage drop across the precipitator electrodes.

As is known, the efficiency of precipitation is determined by the mean voltage across the precipitator, and therefore a lower mean voltage reduces the efficiency of dust precipitation and the efficiency of dust gathering by the precipitating electrodes. When cleaning gases of high-resistance dust, the main mechanism reducing the efficiency of charging and precipitating the dust particles is corona backfire at the precipitating electrode. A pulsed supply waveform allows elimination of corona backfire and thus makes it possible to intensify the process of dust particles charging and precipitation on the precipitation electrode.

When cleaning gases from dust with a specific electric resistivity below 10^9 Ohms·m (medium-resistance dust) a low mean voltage across the precipitator electrodes due to bell-shaped pulse waveforms leads to a low velocity of charged particle drift to the precipitating electrodes, this resulting in a lower cleaning efficiency of the precipitator, despite the particles acquiring a higher charge due to pulse power supply.

Disclosure of the Invention

This invention is to provide a pulse voltage supply for electrostatic precipitators, the design configuration whereof, by increasing the mean voltage, would improve the efficiency of gas cleaning in electrostatic precipitators.

This is achieved by that in the pulse voltage supply for electrostatic precipitators, comprising a step-up transformer with the primary thereof connected to a sine voltage supply via a thyristor controller, a control unit with the outputs thereof connected to the thyristor gates in the thyristor controller, a precipitator parameters sensor with the inputs thereof connected to the corona-forming and precipitating electrodes of the electrostatic precipitator and with the output thereof connected to the input of the control unit, a bridge rectifier with the inputs thereof connected to the secondary of the step-up transformer and with the first and second outputs thereof electrically connected to the corona-forming and precipitating electrodes, a capacitor with the first lead thereof connected via connected in series choke and electronic key shunted by an opposite connected gate to the corona-forming electrode of the electrostatic precipitator and with the second lead thereof connected to the precipitating electrode of the electrostatic precipitator, a pulse generator with the outputs thereof connected to a heavy-duty contact terminal and to the control input of the electronic key, according to the invention the outputs of the bridge rectifier are directly connected to the corona-forming and precipitating electrodes of the electrostatic precipitator.

The use of this invention allows improvement of gas cleaning efficiency from dust with a specific resistivity below 10^9 ohm.m (medium-resistance dust) by increasing the mean voltage across the electrostatic precipitator electrodes, while applying a pulse voltage to these electrodes.

Brief Description of the Accompanying Drawings

The invention will now be described in greater detail, with reference to specific embodiments thereof and to the accompanying drawings, wherein:

Fig. 1 shows the block diagram of the pulse voltage supply for electrostatic precipitators, according to the invention;

Fig. 2a shows a plot of the voltage at the output of the sine voltage supply as a function of time;

Fig. 2b shows the voltage across the electrodes of the electrostatic precipitator as a function of time;

Fig. 2c shows a plot of the output voltage of the control unit as a function of time;

Fig. 2d shows a plot of the output voltage of the pulse generator as a function of time.

Preferred Embodiment

The pulse voltage supply for electrostatic precipitators comprises thyristor controller 1 (Fig. 1) designed with two thyristors 2,3 in parallel-opposition connection. Thyristor controller 1 is connected to the first terminal of primary 4 of step-up transformer 5. Primary 4 of step-up transformer 4 has its first terminal connected to a sine voltage supply (not shown in the Figure) via thyristor controller 1 and its second terminal directly connected to this sine voltage supply. Secondary 6 of step-up transformer 5 is connected to the inputs of bridge rectifier 7 comprising diodes 8,9,10,11. The first output (negative terminal) of bridge rectifier 7 is connected directly to corona-forming electrode 14 of electrostatic precipitator 13, with precipitating electrode 14 thereof connected to common bus 15. The second output (positive terminal) of bridge rectifier 7 is connected to common bus 15. The pulse voltage supply further comprises control unit 16 of generally known design (T.M. A.Aliev. "Agregati pitaniya elektrofiltrov" (Electrostatic Precipitator Power Supplies), Moscow, Energoizdat Publishers, 1981, pp. 53-60. In Russian). The output of control unit 16 is connected to gates 17 of thyristors 2,3 in thyristor controller 1. The pulse voltage supply yet further comprises capacitor 18 with the first lead thereof connected via a network of connected in series first choke 19 and electronic key 20 to corona-forming electrode 12 of electrostatic precipitator 13, with electronic key 20 shunted by connected in opposition to it gate 21 and second choke 22. The second lead of capacitor 18 is connected to common bus 15.

The outputs of pulse generator 25 are connected to the terminal of heavy-duty contact 23 and to control input 24 of electronic key 19. The repetition rate of pulse generator 25 is preset individually for each dust precipitation process, according to the properties of the dust being precipitated. The pulse repetition rate remains approximately constant during the entire process.

The pulse voltage supply comprises voltage sensor 26 serving as a sensor of the electric parameters of the electrostatic precipitator and designed as a voltage divider with resistors 27, 28 connected in parallel to electrostatic precipitator 13. The first lead of voltage sensor 26 is connected to corona-forming electrode 12 of electrostatic precipitator 13, the second lead is connected to common bus 15, with sensor 26 output connected to the input of control unit 16.

The pulse voltage supply for electrostatic precipitators functions as follows.

Voltage U_1 (Fig. 2a) from a sine voltage supply (not shown) is applied to primary 4 (Fig. 1) of step-up transformer 5 via thyristor controller 1. The voltage from the terminals of secondary 6 of step-up transformer 5 is applied to the input of bridge rectifier 7, the output voltage whereof features an amplitude and frequency determined by the properties (specific resistivity) of the dust being precipitated by electrodes 12 and 14 of electrostatic precipitator 13. The output signal of voltage sensor 26 carries data on processes taking place in electrostatic precipitator 13, such as corona discharge in the precipitator, dust particle charging and drift to the precipitating electrode, precipitation of dust particles on this latter, to the input of control unit 16.

Voltage pulses U_{i1} (Fig. 2c) from the output of control unit 16 are applied to the gates in thyristor controller 1, with the algorithm of the pulse sequence dependent on the processes taking place in electrostatic precipitator 13 (Fig. 1) and determining the firing angle of thyristors 2,3 in thyristor controller 1. As a result, firing thyristors 2,3 of thyristor controller 1 at the moment of time t_0, voltage U_1 (Fig. 2a) transformed by step-up transformer 5 (Fig. 1) and rectified by bridge rectifier 7 charges the equivalent capacitance between the corona-forming electrode 12 and precipitating electrode 14 of electrostatic precipitator 13. At a disabled electronic key 20, voltage U_2 (Fig. 2b) across electrodes 12, 14 of electrostatic precipitator 13 (Fig. 1) features a pulsed rectified waveform with the ripple frequency and voltage amplitude (Fig. 2b) equal to twice the frequency of the sine voltage U_1 (Fig. 2a) and approximately 1.45 ripple amplitude (Fig. 2b).

Voltage U_2 (Fig. 2b) is maintained at a level, corresponding to breakdown of the interelectrode gap in electrostatic precipitator 13 by the signal arriving from the output of control unit 16 (Fig. 1). Capacitor 18 is charged via gate 21 to a voltage of U_1 magnitude (Fig. 2a) simultaneously with charging the interelectrode capacitance of electrostatic precipitator 13.

With enabled electronic key 20 (Fig. 1), voltage pulses U_{i2} (Fig. 2d) arriving at the moment time t_1 from the output of pulse generator 25 (Fig. 1) at the terminal of heavy-duty contact 23 and at control input 24 of electronic key 20 establish an oscillatory process in the network capacitor 18 - electrodes 12, 14 of electrostatic precipitator 13, this causing voltage pulses U_i with durations of dozens and hundreds of microseconds to be superimposed onto pulsed rectified voltage U_2, and applied across electrodes 12, 14 of electrostatic precipitator 13.

Due to corona-forming and precipitating electrodes 12, 14 (Fig. 1) of electrostatic precipitator 13 being directly connected to the outputs of bridge rectifier 7, the mean value of voltage U_c (Fig. 2b) applied to electrodes 12, 14 of electrostatic precipitator 13 is increased by an increased amplitude U_a (Fig. 2b) of the voltage. This leads both to an increased charge of dust particles by voltage pulses U_i and to a higher velocity of dust particle drift to precipitating electrode 14 (Fig. 1) in electrostatic precipitator 13. As a result, the efficiency of gas cleaning from dust with a specific resistivity below 10^9 Ohm•m (medium resistance dust) is improved.

The use of the pulse voltage supply for electrostatic precipitators improves the efficiency of gas cleaning, reduces wear of electrostatic precipitators and prolongs their service life, and reduces power consumption.

Industrial Applicability

This invention can be advantageously applied in thhermal power engineering, in ferrous and non-ferrous metallurgy, in the chemical industry, and in the construction material industry.

CLAIM

A pulse voltage supply for electrostatic precipitators, comprising a step-up transformer (5) with primary (4) thereof connected via thyristor controller (1) to a sine voltage supply, control unit (16) with the outputs thereof connected to the gates of thyristors 2,3 in thyristor controller (1), an electrostatic precipitator electric parameters sensor (26) with the inputs thereof connected to corona-forming electrode (12) and precipitating electrode (14) of electrostatic precipitator (13) and with the output thereof connected to the input of control unit (16), bridge rectifier (7) with the inputs thereof connected to secondary (6) of step-up transformer (5) and with the first and second outputs thereof electrically connected to corona-forming electrode (12) and to precipitating electrode (14) of electrostatic precipitator (13), capacitor (18) with the first lead thereof connected via a connected in series network of choke (19) and electronic key (20) shunted by opposition connected gate (21) to corona-forming electrode (12), of electrostatic precipitator (13) and with the second lead thereof connected to precipitating electrode (14) of electrostatic precipitator (13), pulse generator (25) with the outputs thereof connected to the terminal of heavy-duty contact (23) and to control input (24) of electronic key (20), characterized by that the outputs of bridge rectifier (7) are directly connected to corona-forming electrode (12) and precipitating electrode (14) of electrostatic precipitator (13).

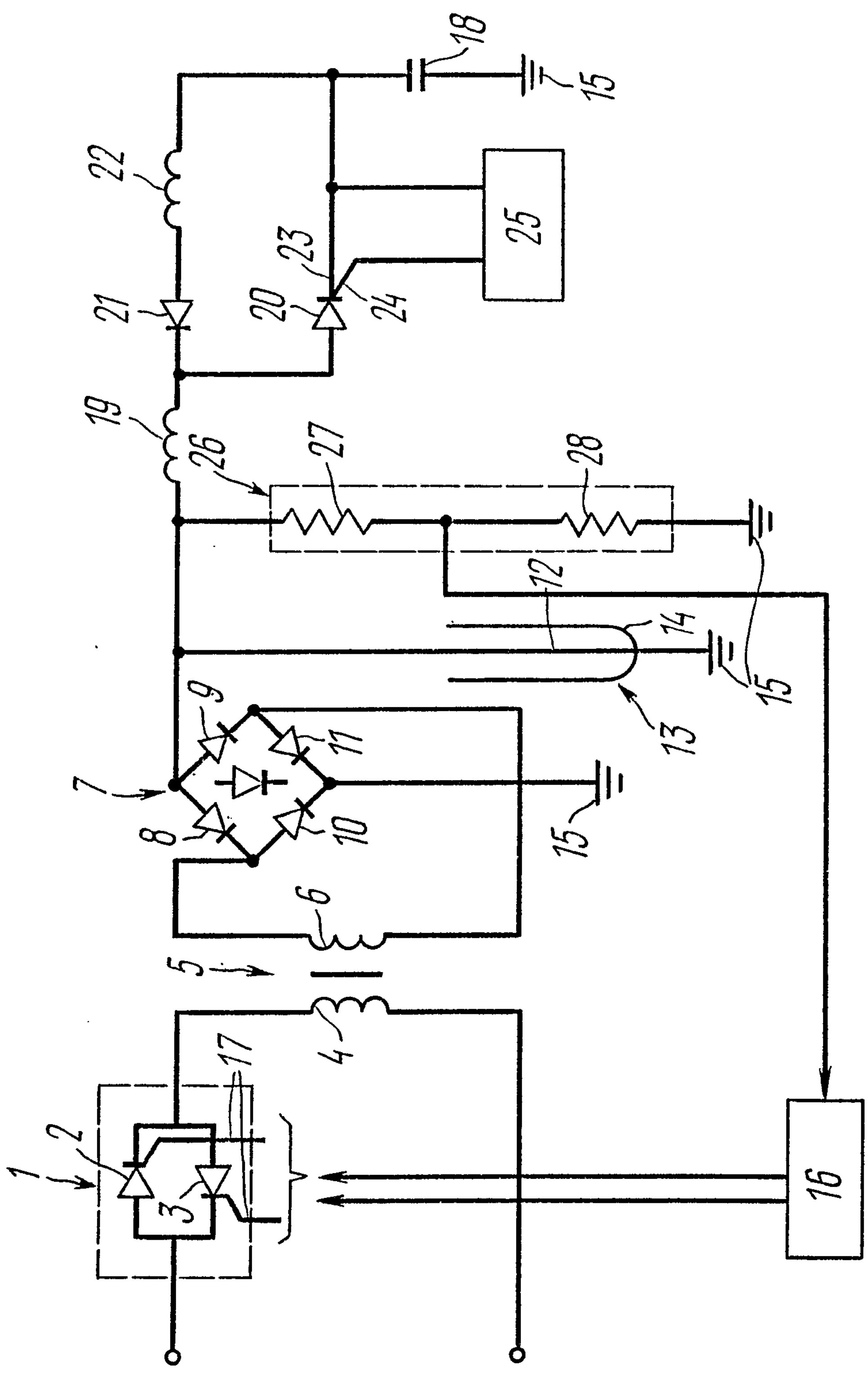

FIG. 1

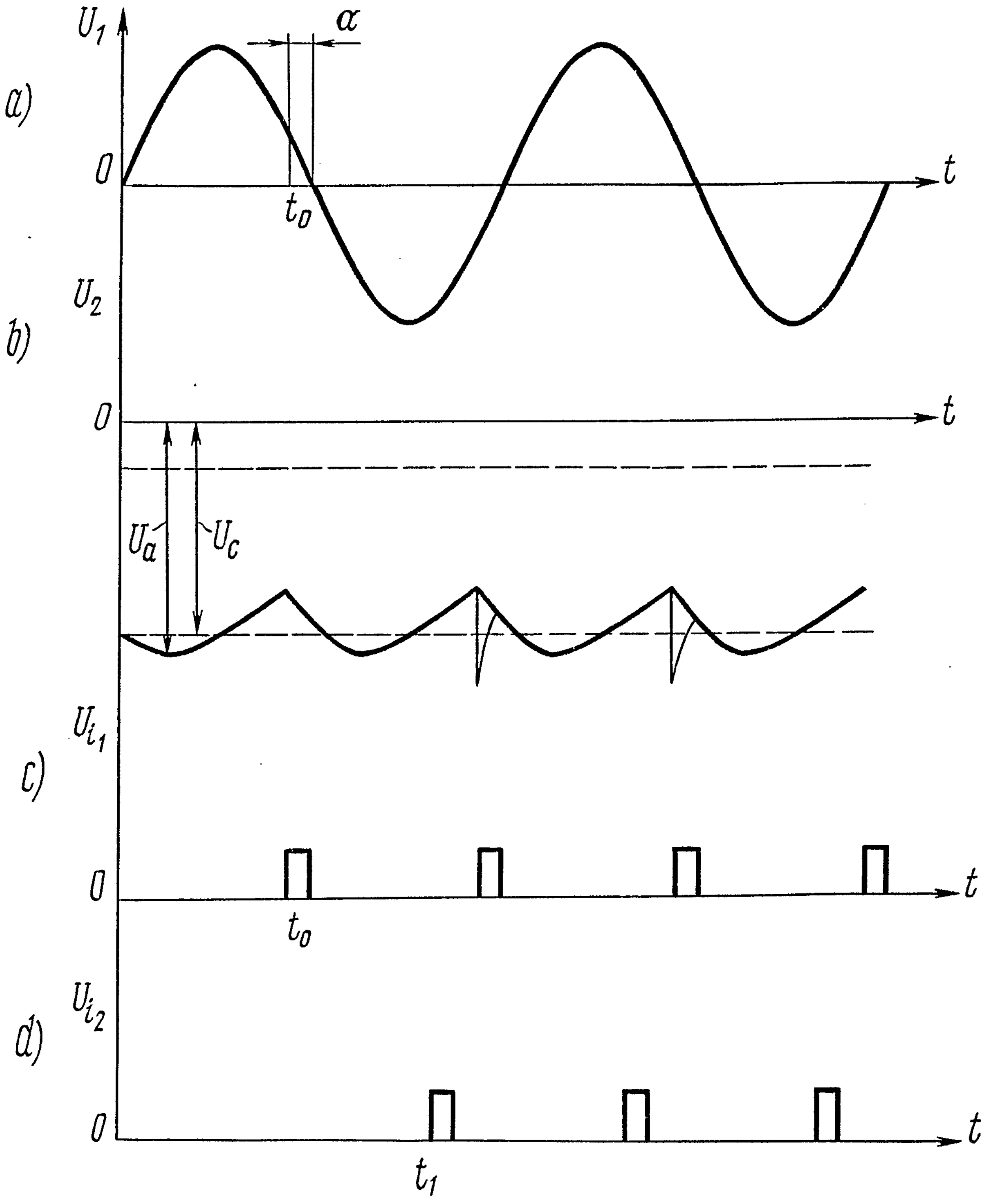

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SU 88/00157

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4] B 03 C 3/68, 3/38

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 03 C 3/38, 3/68

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 4626261 (F.L. SMIDTH & CO. A/S), 2 December 1986 (02.12.86), see fig. 1	1
A	DE, A1, 3525557 (SUMITOMO HEAVY INDUSTRIES, LTD.), 30 January 1986 (30.01.86), see fig. 5	1
A	SU, A1, 1282100 (Nauchno-issledovatelsky i proektny institut po gasoochistnym sooruzheniyam, tekhnike bezopasnosti i okhrane truda v promyshlennosti stroitelnykh materialov), 7 January 1987 (07.01,87), see the drawing	1
A	SU, A1, 1268207 (Moskovskoe otdelenie nauchno-issledovatelskogo instituta po peredache elektroenergii postoyannym tokom vysokogo napryazhenia), 7 November 1986 (07.11.86), see fig. 1	1

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25 April 1989 (25.04.89)	5 May 1989 (05.05.89)
International Searching Authority	**Signature of Authorized Officer**
ISA/SU	