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328-227

June 25, 1968 G. BREYNAT ET AL 3,390,342

ION BEAM REMOTE CONTROL DEVICE HAVING PULSE SHAPING AND RESTORING MEANS

Filed July 20, 1965 3 Sheets-Sheet 1

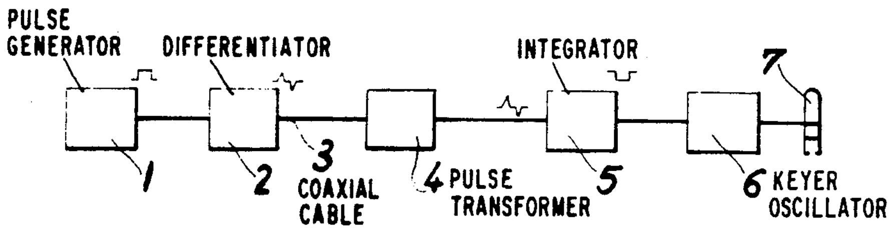

FIG. 1

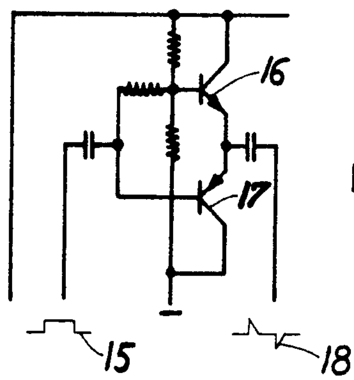

FIG. 2

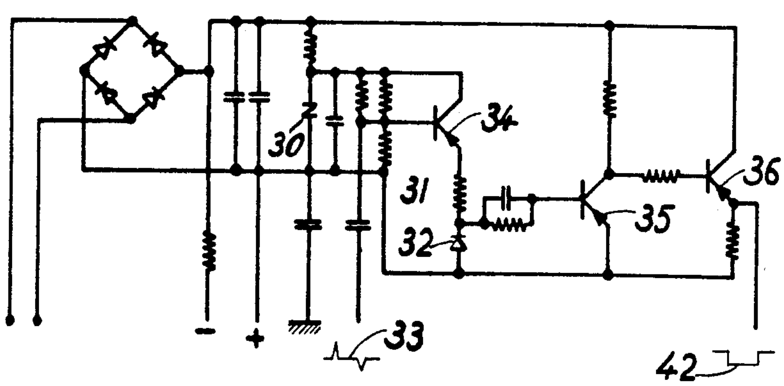

FIG. 5

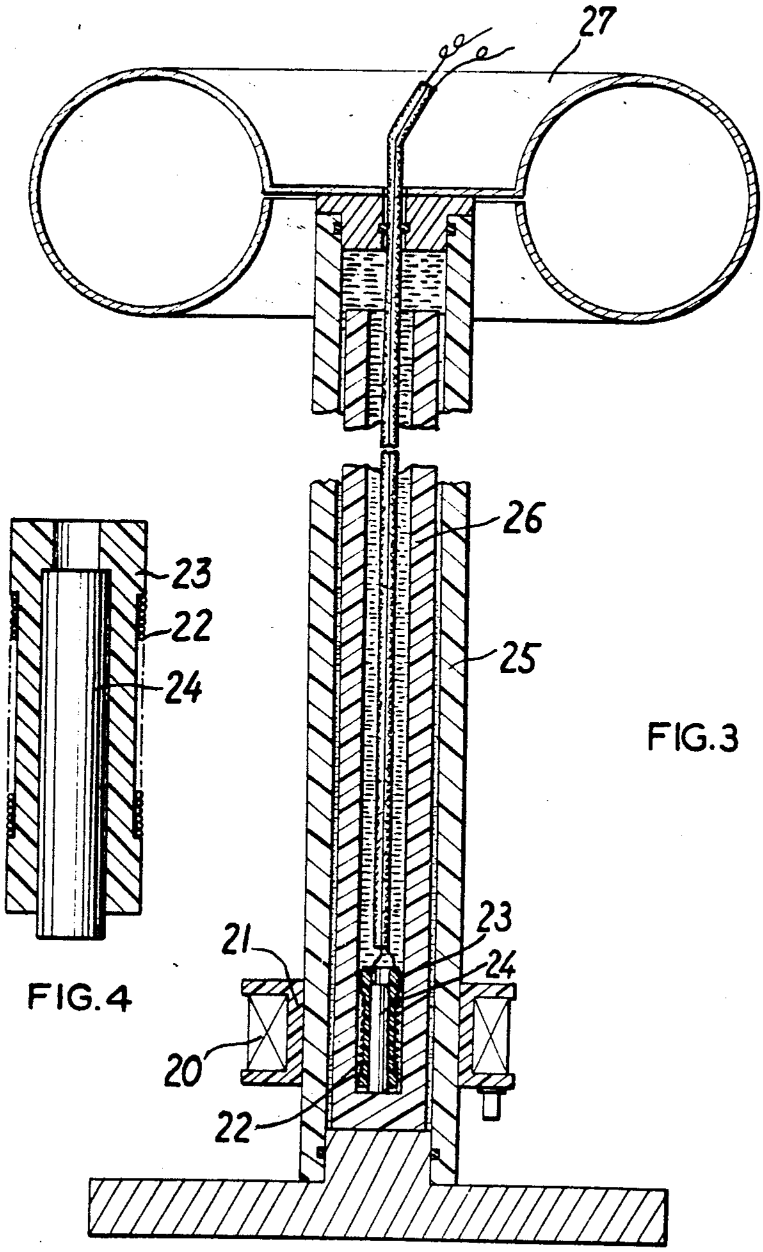

FIG.3

FIG.4

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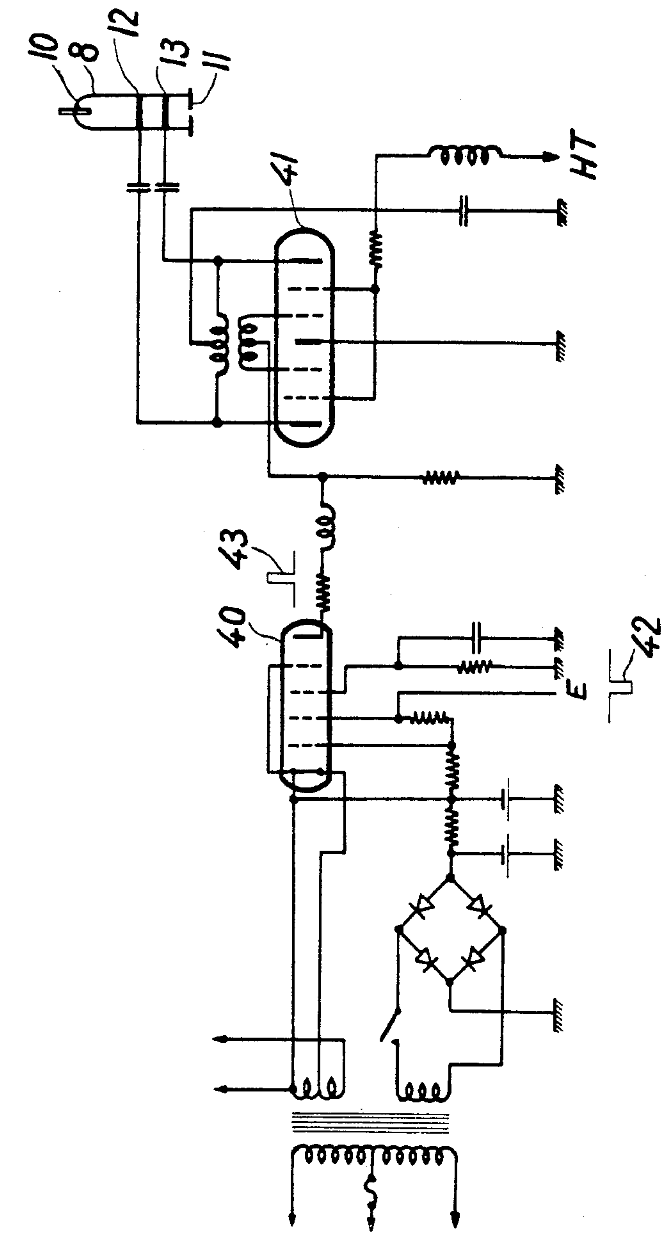

FIG.6

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ION BEAM REMOTE CONTROL DEVICE HAVING PULSE SHAPING AND RESTORING MEANS

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4 Claims. (Cl. 328—227)

The present invention relates to a device for the remote-control of the ion-beam created by an ion-source submitted to a high frequency electric field, said device having its pulse-generator located near a control desk far from the ion-source.

More precisely, the present invention relates to an ion-beam remote control device which is characterized in that it comprises a pulse-generator which emits rectangular signals and is adapted to control a differentiator and impedance reducer, the resulting thus differentiated signal being transmitted via a long coaxial cable to a step-down pulse-transformer adapted to actuate an integrator which in turn, feeds a reconstituted rectangular but phase-inverted signal to a keyer adapted to provide the alternate blocking and unblocking of a high frequency oscillator.

According to a further feature of the invention, said transformer comprises, inside a first insulating tube around which is wound the transformer primary winding, a second insulating tube coaxial therewith and forming a well at the bottom of which is located the transformer secondary winding.

The duration of the ion pulses is adjusted by the pulse generator, at the control desk. Once it has been differentiated, the signal can be transmitted, at low impedance, to the primary of the transformer, via a long coaxial cable. The voltage at the exit of the transformer is chosen high enough for actuating the integrator without the need of an amplifying stage; once it has been restored by the integrator, the signal controls a conventional keyer-oscillator unit which, in turn, actuates the ion-source.

The features of the present invention will be disclosed hereafter, reference being had to the accompanying drawing in which:

FIG. 1 is a block-diagram of the device according to the invention;

FIG. 2 shows the differentiator and impedance reducer of said device (reference 2 in FIG. 1);

FIG. 3 shows the step-down pulse-transformer of said device (reference 4 in FIG. 1);

FIG. 4 shows the lower portion of the transformer of FIG. 3, on an enlarged scale;

FIG. 5 shows the integrator of said device (reference 5 in FIG. 1); and

FIG. 6 shows the keyer-oscillator of said device (reference 6 in FIG. 1).

From the control desk to the ion source, the device according to the invention successively comprises (as shown by FIG. 1) a pulse-generator **1** the output of which is connected to the input of a unit **2** acting as a differentiator and an impedance reducer, a long coaxial cable **3**, a step-down pulse-transformer **4**, an integrator **5** and a keyer-oscillator unit **6**, and later being coupled to ion-source **7**.

Pulse-generator **1**, of a conventional type, and differentiator **2** are located in the vicinity of the control-desk, whereas transformer **4** and the other units are mounted in the vicinity of the ion-source, differentiator **2** and transformer **4** being connected by long coaxial cable **3**.

As more clearly shown in FIG. 2, unit **2** comprises a

resistor-capacitor circuit for deriving signals and two push-pull mounted transistors **16** and **17**.

The step-down pulse-transformer **4** is insulated up to about, e.g., 200 kv. Between its primary (connected to unit **2** by long coaxial cable **3**) and its secondary (connected to integrator **5**), this transformer withstands all the acceleration voltage, and it restores the pulses applied thereto, without any substantial distortion.

As shown in FIG. 3, the primary **20** of transformer **4** is wound around a spool of "nylon" or of a similar material, and it comprises 300 turns. The impedance of said primary must be high enough with respect to the cable resistance (100 ohms in the specific example disclosed) in order to avoid over-shoots whatever be the characteristics of the pulses provided by generator **1**.

The secondary **22** of transformer **4**, formed of 40 turns, is also wound around a spool **23** of "nylon" in the central portion of which is a core of ferrite **24**. Insulation is ensured by a tube **25** of "Haeffelite" mounted inside spool **21** of the primary and the height of which is about 60 in. (150 cm.), whereas that of spools **21** and **23** is of about 5 to 6 in. (12 to 15 cm.). A large diameter torus **27** defines an equipotential surface which is wide enough for preventing ionization in connection cables.

Within tube **25** and coaxial therewith is mounted a well **26** of "Araldite," at the bottom of which is located spool **23** around which is wound the secondary. Well **26** and tube **25** are filled with transformer oil which has been dehydrated before filling.

The flip-flop integrator stage **5** shown in FIG. 5 comprises its own source of direct voltage from the alternating voltage furnished by the transformer of unit **6**; stage **5** can also be fed independently; a zener-diode **30** provides the stabilized voltage required for feeding the flip-flop. The latter is constituted by a resistor **31** and a tunnel diode **32**. The output signal **33** of the pulse-transformer attacks said flip-flop through transistor **34** which acts as an impedance reducer. The resulting signal is amplified by transistor **35** and fed at low impedance to the input of unit **6**, through transistor **36**.

The keyer-oscillator unit **6** (FIG. 6) essentially comprises an amplifier tube **40** and an oscillator **41**, the grid of which is normally kept at a negative voltage by tube **40**, said oscillator **41** being coupled to ion-source **7** by means of two rings **12** and **13**.

Ion-source **7**, of a conventional type, consists in an envelope **8** provided with an extraction slit **11** and an anode **10** for applying the extraction field; two rings **12** and **13** connected to HF oscillator **6** serve to create a high frequency electric field in ion-source **7**.

The above-described device operates as follows: pulse-generator **1** emits positive rectangular signals **15**, the duration and repetition frequency of which can be adjusted at will. These signals are differentiated and have their impedance reduced by stage **2** which, in turn, emits signals **18** which are fed, via the long coaxial cable **3** (which is for instance 500 feet long), to the primary of step-down pulse-transformer **4**. The thus differentiated signals cannot be distorted by said pulse-transformer. The latter, at the output of its secondary, provides pulses the level of which is about $\frac{1}{10}$ of the voltage of the pulses at the input of the primary; said transformer **4** is an impedance matching device for terminating the coaxial cable **3**; flip-flop integrator stage **5**, fed by the signal **33** emitted by the secondary, in turn, feeds a reconstituted rectangular but phase-inverted (therefore negative) signal **42** to the input of stage **6**, i.e., to the control-grid of amplifier-tube **40**, and the latter ensures the alternate blocking and unblocking of oscillator **41**, which thus generates electric oscillations. Whenever, a signal **42** unblocks oscillator **51**, the ionization due to the high frequency electric field in the ion-source **7** is very high, and the ionic flow through extraction-slit **11** of the ion-source is maximum, whereas, whenever oscillator **41** is blocked, the ionic flow vanishes.

The device forming the object of the present invention can in particular be applied to the production of a pulsed ion-beam intended to generate a beam of neutrons.

What is claimed is:

1. A device for remote control of an ion beam from an ion source subjected to a high frequency electric field comprising, connected in series, a pulse generator emitting rectangular signals, a differentiating and impedance reducing unit connected to said generator and actuated by said generator and altering the signals emitted by said generator, said generator and said unit being located adjacent a control desk, a long coaxial cable, one end of said cable being connected to said unit, a step-down pulse transformer having primary and secondary windings connected to the other end of said cable, said primary windings of said transformer receiving the differentiated signals emitted by said unit, an integrator connected to said secondary windings and actuated by the signals emitted by said secondary windings, said integrator emitting reconstituted, rectangular, phase-inverted signals, a keyer connected to said integrator and actuated by the reconstituted signals, a high frequency oscillator connected to said keyer and alternately blocked and unblocked by said keyer, and two rings mounted on said ion source and connected to said oscillator generating a high frequency electric field in said ion source whereby when said oscillator is blocked the ionic flow is substantially zero and when said oscillator is unblocked the ionic flow is maximum.

2. A device as described in claim **1**, said differentiating and impedance reducing unit comprising a resistor capacity circuit and two push-pull mounted transistors.

3. A device as described in claim **1**, said step-down pulse transformer comprising a first insulating tube, said primary winding being mounted around said first tube, a second insulating tube mounted inside said first tube, a well of insulating material within said second insulating tube, a spool at the bottom of said well, a core of ferrite within said spool, said secondary winding being mounted around said spool and a large diameter torus on said first tube defining an equipotential surface preventing ionization in connection cables.

4. A device as described in claim **1**, said keyer oscillator comprising an amplifier tube, a control grid for said tube receiving the signals emitted by said integrator, an oscillator and a grid for said oscillator normally kept at negative voltage by said tube.

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