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APPARATUS WITH FOCALIZED ELECTRONIC
BEAM, SUCH NAMELY AS MICROSCOPES
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Fig:1

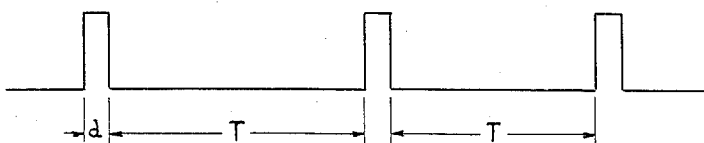
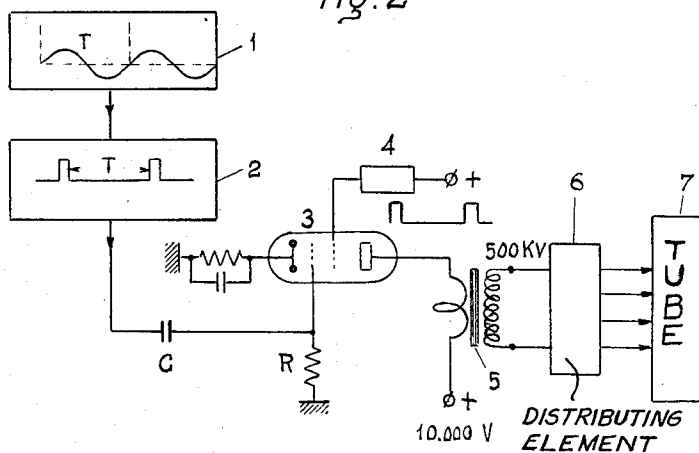


Fig:2



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APPARATUS WITH FOCALIZED ELECTRONIC BEAM, SUCH NAMELY AS MICROSCOPES

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4 Claims. (Cl. 315—14)

The invention refers to apparatus including a focalized electronic beam, and more particularly a fixed beam used either for the purpose of magnifying in a microscope, or for analysis of crystals through diffraction, or for the production of X rays, or for any other similar purpose.

All that family of apparatus must be supplied with very high voltages which are necessary to subject the electronic beam to a strong acceleration imposed by their operating conditions. Electrons with a very great velocity are indispensable in a microscope in order to ensure a great separating power determining its magnifying coefficient and moreover, in order to ensure a certain penetration in the material to analyse; the same considerations play in an analyser operating by diffraction; and finally, in the X rays apparatus, the velocity of impact of the beam upon the anticathode determine the power of the X radiation and its strength of penetration.

The electronic beam is produced inside a vacuum tube and the high voltage supply is applied between the electrodes of that tube. In the case of electronic microscopes, these electrodes are, for example, the elements constituting an electrostatic lens. In the X rays tubes, the voltage is applied between the cathode and the anticathode. The experience teaches that it is very difficult to reach voltages of about one hundred of kilovolts between these electrodes without taking expensive precautions; such as extremely exhausted vacuum, polishing and degasing of electrodes, etc. Otherwise between the electrodes, discharges take place and limit the amplitude of the high voltage which may be applied. The analysis of these discharge phenomenons shows that the time necessary for the discharge to happen, after application of the voltage is particularly a function of that voltage value and of the degree of vacuum. The higher the voltage is, the more rapidly the discharge takes place. The presence of ions due to imperfect vacuum contributes at its turn to increase the danger of untimely discharges and cracking, a danger which is all the more apparent as the duration of application of intense electric field is greater.

Until now, the supply of these apparatus was secured by direct voltages produced by means of a rectifying arrangement, the amplitude of which was limited by the above explained considerations. It is an object of the present invention to provide a new system of voltage supply permitting very much to increase the values of the supply voltages without endangering the apparatus with the risk of damages. It more particularly allows, either to very much increase the velocity of electrons for the same distances of the electronic system-generator and focalizer of the beam, or, in keeping the same velocity, much to reduce these distances, and therefore the dimensions of the apparatus.

More particularly, it aims at an electronic microscope and similar apparatus, with increased penetration power of the electrons, permitting to make analysis in depth, to examine relatively thick objects and thus to reveal the structure of preparations which had so far shown themselves opaque.

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Finally, it aims at apparatus such as microscopes of reduced dimensions, and offering a greater operating range and a greater facility of handling.

According to the invention, the different elements of the vacuum tube are supplied with high voltage appearing in form of intermittent impulses of very short duration and very great amplitude.

According to the invention, these impulses are preferably given a steady rectangular form.

According to the invention, their recurrence frequency is adjusted according to the degree of vacuum, and particularly according to the duration of the deionization of the tube.

According to the invention the supplying part of the apparatus includes a master-oscillator, the frequency of which is easy to adjust, means for transforming its output into short periodic impulses, power relays amplifying them, a transformer transforming them into high voltage impulses say of several hundreds of kv., and a distributing element with several tappings connected to the utilisation tube.

According to the invention it will be possible to subject the tube itself to any constructive modification imposed by that new type of feeding, or permitting to turn it at best to account.

The invention will be better understood, with the help of the enclosed drawing, giving a particular type of embodiment, as a non limiting example, and on which the Figure 1 shows a diagram of the voltage impulses used according to the invention and the Figure 2, a diagram of the feeding device supplying these impulses.

In the voltage impulses of Figure 1, the value of the voltage may reach several hundreds of kilovolts. The duration d is adjusted so as to be much shorter than the time necessary for initiating a discharge. In the tubes of the usual type, it was possible to operate with durations of the order of 1–5 μ s.

The applicant has verified that it is possible, during that very short time, to subject the electrodes to much higher voltages than the security voltages imposed to a direct current supply. No partial disintegration of the metal or of any other part of the tube which might initiate a discharge or destroy its insulation, is to apprehend so long as the electric field, even a very intense one, exists only during that very short interval of time.

The recurrence frequency of the impulses is chosen so that the time T between two consecutive impulses is long enough to permit the full deionization of the residual gases, in order to avoid any cumulative effect of the traces of ionization produced by successive impulses. It is particularly convenient to choose an interval T of the order of 50 μ s.

In order to avoid any interference on the focalization, these impulses are maintained at a strictly constant level. The feeding of impulses used with an electronic microscope or an X rays tube, does not present any inconvenience except a decrease of the image luminosity, upon condition of using impulses of rectangular shape. This decrease of luminosity is partially compensated by increase in voltage. It would be possible to completely avoid the decrease of luminosity by the use of a cathode capable of emitting a more intense electronic beam for the duration of the impulse (particularly an oxide or thoria cathode).

The electronic microscope apparatus in use are generally fed in D. C. voltage, of some tens of kv. Already, these voltages put problems of form, arrangement and isolation of the electrodes, and more particularly of the electrostatic lenses elements. The invention permits to use voltages of several hundreds of kv., and, by so considerably increasing the velocity of electronic impact, to let the electrons deeply penetrate into the material to be

analysed, and so to reveal the structures on a certain depth.

Of course, the above numerical values are given but as example, and they can be modified in both directions according with the type of apparatus and the operation required.

On the Figure 2, number 7 indicates the vacuum part of the apparatus, which is the utilisation element properly so called, and can particularly be a microscope tube which inside an airtight enclosure confines the electronic gun, the electrostatic lenses and the means to introduce the object and produce its desired image, directly or by photographic way. The stage 1 includes a master-oscillator which supplies a sinusoidal voltage at the frequency of the impulses recurrence. That voltage is transformed by the stage 2 in a suite of short rectangular impulses having the same recurrence frequency. The means for realizing such an operation being now classical in impulses technique, it has not been found necessary to show them. They can particularly include an electron tube loading an inductance attenuated at the critical degree by a resistance. The peaks of voltage so produced can be levelled by means of other electron tubes. That stage operates a power amplifying tube 3, through a circuit C—R, calculated so as its constant be great with respect to the frequency of repetition. This tube, operating for example, with an anodic voltage of 10,000 volts and supplying rectangular impulses of the current, feeds the primary of a transformer of impulses 5 provided with a magnetic core so provided as to maintain the rectangular form of the impulses and for that purpose presenting a very high load impedance. The secondary is connected to a distributing element 6 appearing as a potentiometer provided with various voltage tapping, assuming the form, either of an isolating rod of very great resistance either of a capacity bridge, or of any other appropriated form, particularly introducing no shift of phase and supporting the above mentioned voltages.

In operating, by means of a potentiometer 4, on the voltage of the screen grid, it is possible to adjust the amplitude of the impulses supplied by the transformer, while maintaining their form.

The said distributing element could be avoided, if tappings for distribution are provided directly on the secondary of the transformer.

What we claim is:

1. An intermittent voltage supply for electronic microscopes comprising in combination, an electronic microscope having a beam accelerating and focussing electrodes, the electronic microscopes being operated with a fixed and focussed beam; a master oscillator for generating a sinusoidal voltage; means for transforming said sinusoidal voltage into periodically recurrent unidirectional

impulses; means for stepping up the voltage of said periodically recurrent unidirectional impulses into high voltage unidirectional impulses; and means for applying said high voltage periodically recurrent impulses directly to said beam accelerating and focussing electrodes of the electronic microscope whereby said electronic microscope is rendered conductive during that time only in which said periodically recurrent impulses are generated and applied to said beam accelerating and focussing electrodes.

2. An intermittent voltage supply for electronic microscopes having a beam accelerating and focus electrodes, the electronic microscopes being operated with a fixed and focussed beam, comprising in combination, a master oscillator for generating a sinusoidal voltage; means for transforming said sinusoidal voltage into periodically recurrent unidirectional impulses, said unidirectional impulses having a rectangular shape and being generated at time intervals substantially greater than the pulse length; an amplifier connected at its input terminals to said means for transforming said sinusoidal voltage into periodically recurrent unidirectional impulses, said amplifier having an anode; and a step-up transformer having a primary and a secondary winding, its primary winding being connected at one end thereof to said anode of said amplifier and at the other end thereof to a high voltage direct current voltage source, the output of said secondary winding of said step-up transformer being applied directly to said beam accelerating and focussing electrodes of the electronic microscope whereby said electronic microscope is rendered conductive during that time only in which the amplified periodically recurrent impulses are connected to said beam accelerator and focussing electrodes.

3. Apparatus as claimed in claim 2 and in which means are operatively connected to said amplifier for adjusting the amplitude of said periodically recurrent impulses.

4. An intermittent voltage supply as claimed in claim 2 and in which a voltage divider is connected across the secondary winding of said step-up transformer.

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