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W. K. KEARSLEY, JR

1,683,139

VIBRATING REGULATOR

Filed Dec. 13, 1921

Fig. 1.

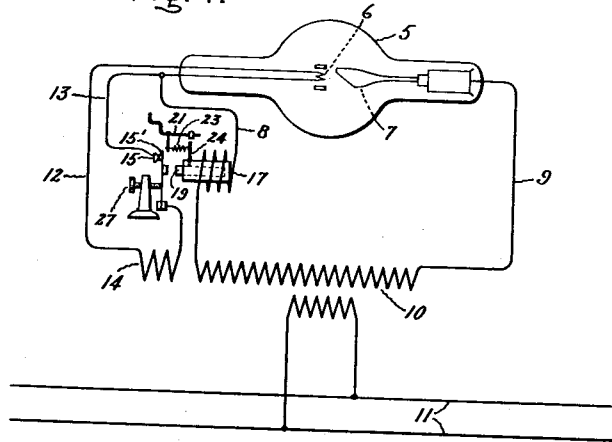


Fig. 2.

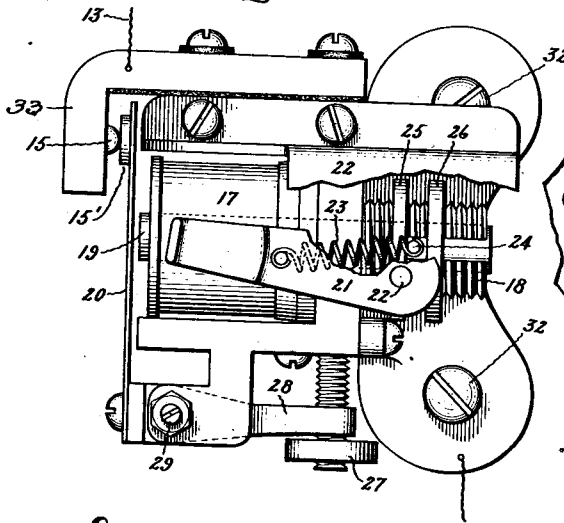


Fig. 3.

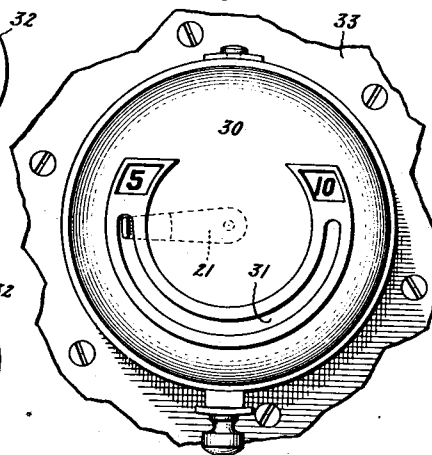
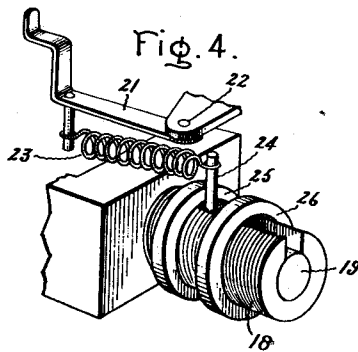


Fig. 4.



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UNITED STATES PATENT OFFICE.

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VIBRATING REGULATOR.

Application filed December 13, 1921. Serial No. 522,137.

The present invention relates to the regulation of electron devices in which the cathodes are heated by passage of current and particularly to X-ray tubes. Its object is to provide means whereby the cathode heating current may be set at will at different values, thereby correspondingly changing the electron or space current. My invention in some of its aspects is not limited to the regulation of electronic devices.

In my prior Patent 1,653,102, patented December 20, 1927, I have described an X-ray apparatus provided with a regulator for controlling the cathode temperature in order to maintain current through the tube substantially constant at a desired value. For example, when in an X-ray apparatus a substantially constant X-ray output is desired the electron emissivity of the cathode is controlled in accordance with my prior invention by a regulator acting upon the cathode heating current in response to the current between the main electrodes in the X-ray tube.

In accordance with my present invention, I have provided a regulator whereby the current in the electron tube may be held substantially constant at widely different values, for example, in order to maintain the output of X-rays at different desired constant values. In its preferred embodiment my invention comprises a vibrating regulator provided with a core having a movable element whereby the magnetic reluctance of the device may be altered at will, and in particular may be changed from one fixed value to another fixed value while preventing adjustment to intermediate values.

The novel features of my invention will be pointed out with greater particularity in the appended claims. For a better understanding of my invention reference may be had to the following specification taken in connection with the accompanying drawing in which Fig. 1 comprises a diagram of an X-ray system embodying my invention; Fig. 2 is a plan view of the apparatus (somewhat enlarged) the cover being removed and part of the device being broken away; Fig. 3 is an external view of the regulator, and Fig. 4 shows in perspective a mechanical detail of the regulator.

The X-ray tube 5 of Fig. 1 is provided with a cathode 6 which is adapted to be

heated to incandescence, and an anode 7. The X-ray tube may be of the type described in Coolidge Patent 1,203,495. The electrodes 6, 7 are connected by conductors 8, 9 to the high potential secondary winding of a transformer 10. The transformer primary receives current from a source of alternating current 11. The cathode 6 is connected by conductors 12, 13 to a low potential secondary winding 14. Included in the circuit 13 are make and break contacts 15, 15' which are vibrated by a magnet 17 having a winding in series with the main conductors 8, 9. The contact 15' is mounted on the armature 20, which is supported on the main frame. The contact 15 is carried by an arm 33 which is insulated from the main frame. The core 18 of the vibrator magnet has a movable element 19 adapted to be moved toward and away from the flexible armature 20 of the vibrator by a lever 21.

As best shown in Figs. 2 and 3, the lever 21 is movably attached to a pivot 22, and is connected near its outer end to a spiral spring 23. The opposite end of the spring 23 is connected to a pin 24 mounted on the movable core member 19 and adapted to play back and forth with a snap action between the rings 25, 26, acting as limiting stops which are adjustably mounted upon the core 18. A suitable adjustment of tension of the armature 20 may be made by a screw 27 whereby the lever 28, upon the end of which the flexible armature 20 is mounted, may be moved about the pivot 29.

As the lever 21 is moved through an arc of a circle, it causes the pin 24 to snap from one limiting stop to the other. For example, as the pin 24 moves from the stop 25 to the stop 26 the core element 19 moves by a snap action from one position nearest the armature 20 to another position farther away, thereby increasing the air gap between the core and the armature. The consequent change of magnetic reluctance changes the responsiveness of the vibrator to the current in the main X-ray tube circuit from one predetermined value to another. As a result the relative duration of the periods of make and break are altered and the cathode heating current is maintained at correspondingly different values.

My device is adapted by a proper choice of dimensions to maintain substantially con-

stant a current of one value, say, five milliamperes, with the movable core member 19 extended from the core 18, as shown in Fig. 2, and to operate with a current of ten milliamperes with the movable core member retracted into the core, thereby increasing the air gap. When the movable core member 19 is extended into proximity with the armature 20, the responsiveness of the regulator to a current in the circuit 8, 9 is increased causing the magnet to open the contacts 15, 15' with a lower current, thereby increasing the relative duration of the periods of open circuit with respect to the duration of periods of closed circuit, decreasing the average heating current in the cathode filament and consequently decreasing the electron emission.

The apparatus may be provided with a cover 30 containing a slot 31. The upwardly bent tip of the lever 21 may be moved by the operator from one extremity of the slot 31 to the other, thereby safely changing the setting of the regulator without altering electrical connections. The device may be mounted in any convenient place upon the X-ray tube stand by the screws 32. The mount 33 for the regulator has been merely indicated in broken outline in Fig. 3. Conveniently suitable legends, such as shown in Fig. 3 as "5" and "10" indicate the milliamperage obtained by swinging the regulator lever 21 to either extreme position.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An electric regulator comprising a core, a magnetizing coil therefor, a movable armature, electric contacts for making and breaking an electric circuit operatively connected to said armature, and means for changing the electric reluctance of the magnetic circuit between different values to vary the vibration characteristic of said regulator, said means resisting adjustment to an intermediate value and passing from one respective value to another with a snap action.

2. An electric regulator comprising a core having an extensible element, an armature therefor adapted to vibrate, a magnetizing coil for said core, make and break contacts operatively related to said armature, and means for changing the air gap between the armature and said extensible element to alter the setting of said regulator between predetermined values, said means resisting adjustment to an intermediate value and

passing from one respective value to another with a snap action.

3. An electric regulator comprising a magnetic core having a movable member, an electric winding for said core, a vibrating armature in magnetic relation to said movable core member, electric contacts arranged to make and break a circuit by movements of said armature, a spring connected to said movable core member, a movably pivoted lever connected to said spring and means for limiting the motion of said core member when said lever is moved to a position which alters the direction of traction of said spring upon said core member.

4. An electric regulator comprising an electromagnet, a vibrating armature therefor, electric make-and-break contacts connected to said armature, and means for changing the setting of said regulator from one fixed value to another fixed value while preventing a setting at intermediate values.

5. An electromagnetic regulator having a movable core member, mechanical stops for limiting the movement of said core member, and means for holding said core member at each of said stops and urging said member to one of said stops in an intermediate position.

6. An electric regulator having a vibrating armature, a core therefor containing a fixed member, and a movable member, mechanical stops for limiting the position of said movable core member at two positions with respect to said armature, and means for urging said member against either of said stops but resisting stoppage of said member in an intermediate position.

7. An electric regulator for controlling the cathode heating current of X-ray tubes comprising an electromagnet having a movable member and a stationary member, electric make and break means operatively associated with said electromagnet, a pin extending from said movable core member through a slot in the stationary core member, mechanical stops limiting the motion of said pin, spring actuated means for urging said pin against either of said stops while preventing the pin from remaining in an intermediate position and a hand-operated lever for shifting said pin from one stop to the other.

In witness whereof I have hereunto set my hand this 12th day of December, 1921.

WILLIAM K. KEARSLEY, JR.