No. 774,090. PATENTED NOV. 1, 1904.

H. LEMP.

ALTERNATING CURRENT SELECTOR.

APPLICATION FILED DEC. 1, 1897.

NO MODEL.

FIG. 1.

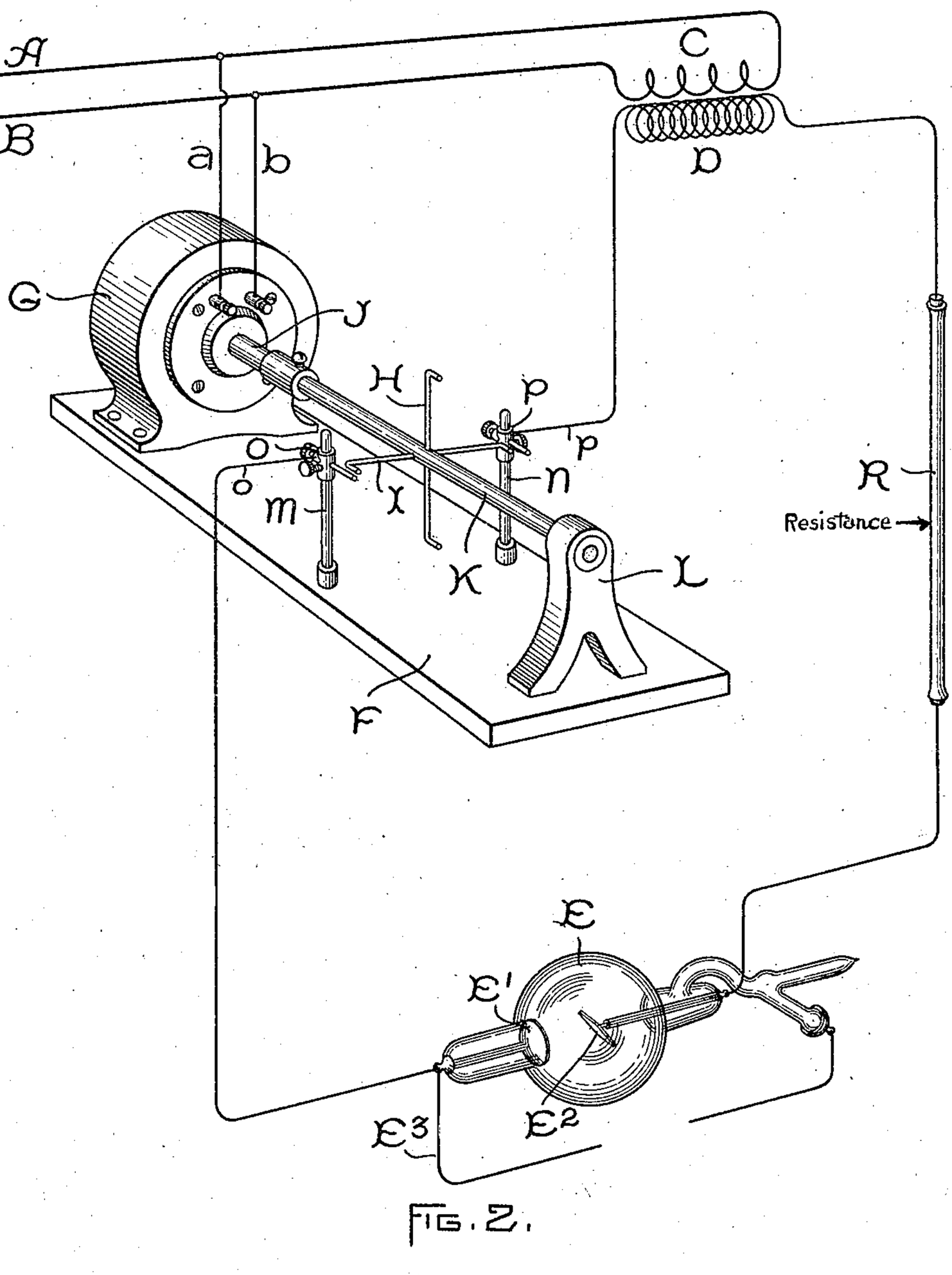
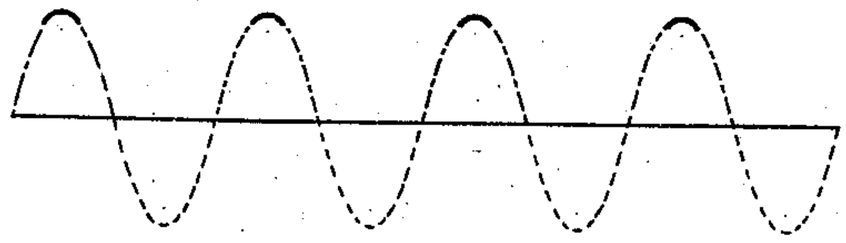


FIG. 2.



WITNESSES:

Arthur H. Abell.

A. F. Macdonald.

INVENTOR:

Hermann Lemp, by

Geo. R. Blodgett,

Atty.

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No. 774,090. Patented November 1, 1904.

UNITED STATES PATENT OFFICE.

HERMANN LEMP, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ALTERNATING-CURRENT SELECTOR.

SPECIFICATION forming part of Letters Patent No. 774,090, dated November 1, 1904.

Application filed December 1, 1897. Serial No. 660,431. (No model.)

To all whom it may concern:

Be it known that I, HERMANN LEMP, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Alternating-Current Selectors, of which the following is a specification.

For exciting Roentgen-ray and similar tubes it is considered highly desirable to employ a unidirectional current, and for this reason a continuous-current source of supply has been almost universally used. An alternating-current source of supply has advantages in certain directions, notably because of the readiness with which the necessary high potential may be secured; but the difficulty of rectifying an alternating current in order to secure from it unidirectional current has heretofore been so great that alternating-current generators have not been used with success.

My invention has for its object to provide an improved apparatus whereby an alternating-current source of supply becomes suitable for Roentgen-ray and other apparatus requiring currents of high potential. The derivation of the desired unidirectional currents from the alternating source is accomplished by what may be termed a "selector," as hereinafter more fully described and claimed.

When employing an alternating-current generator, I propose to utilize only fractions of the waves, preferably the wave crests when the potential is at a maximum. By selecting the wave fractions so utilized from points of like sign in the electromotive-force waves unidirectional discharges through the tube or other apparatus are secured. In this way the tube may be excited by a unidirectional current, and I avoid the heating of the tube which would take place if current corresponding to parts of correspondingly-low voltage in electromotive-force waves were allowed to flow through the tube. In the ordinary types of X-ray tubes practically no rays are produced until the voltage has risen to ten thousand volts. Above this the ray is increased as the voltage rises. The most satisfactory results are obtained when the potential is very high—as, for example, one hundred thousand to one hundred and fifty thousand volts.

In the accompanying drawings, Figure 1 is a perspective view of an embodiment of my invention, certain of the parts being illustrated diagrammatically; and Fig. 2 shows the portion of the current-wave that is utilized to excite the tube.

Mains A and B are connected to any suitable source of alternating current of moderate voltage having a periodicity, for example, of sixty or one hundred and twenty-five cycles per second. Connected across the mains is a step-up transformer having a primary C of comparatively few turns and a secondary D composed of a large number of turns of fine wire, which is employed to excite tube E. The voltage of the secondary will depend upon the voltage of mains A and B; but to obtain the best results the voltage across the secondary mains should be between one hundred thousand and one hundred and fifty thousand volts.

Mounted upon an insulating-base F is a single-phase synchronous motor G, which is connected across the primary mains by wires *a* and *b*. The motor shown in the drawings is provided with eight poles, so that there are four complete positive and negative potential waves during each revolution of the armature. I have found this to be a satisfactory arrangement; but by changing the number of arms H and I a motor having a different number of poles may be employed, provided the number of arms so corresponds with the speed of the synchronous motor that current is allowed to flow at the proper intervals.

Forming an extension of shaft J is an insulating-shaft K, revolving in bearing L and provided with metal arms H and I. Mounted upon the base F are two vertically-extending posts M and N, of insulating material, and provided at their upper ends with adjustable contacts O and P. Contacts O and P are respectively connected to wires *o* and *p* and so adjusted that arms H and I when rotated will pass close to them without making actual contact. Arms H and I are similar in con-

struction, each being made of wire and provided with L-shaped extensions on the ends. These wires may or may not be electrically connected. The potential of the secondary is so great that it is not necessary to have actual contact between the arms and stationary contacts. The instant an arm assumes the position shown by I in the drawings current will jump the air-spaces between arm I and contacts O and P and the resistance of the circuit will be so far reduced that current will flow through tube E. As arm I moves away from the position shown the resistance is increased, so that the circuit is, in effect, interrupted and remains so until arm H has moved to the position now occupied by arm I. With an eight-pole motor there will be four complete positive and negative potential waves for each revolution of the armature, and with the arms arranged as shown current is allowed to flow through tube E for an instant, when the electromotive-force waves reach the maximum and are of like sign. In other words, the relation of the arms and fixed terminals is such that when a positive electromotive-force wave is at or near its maximum an arm will be opposite the terminals, and as the wave rises to its positive maximum again an arm will again be in a position to permit current-flow, the potential being great enough to jump the air-gaps, thus avoiding actual contact. This is more clearly illustrated in Fig. 2, where four complete positive and negative electromotive-force waves are shown, the negative waves being shown in dotted lines and the positive waves in broken and dotted lines. The crests of the positive waves, which are the only portions utilized, are shown in full lines and indicate approximately the length of time current flows across the arms H and I.

I have described my invention as utilizing only the crests of the positive waves; but the same effect is obtained if the crests of the negative waves are utilized. Certain features of novelty in my invention, however, are not limited to sifting out and utilizing the crests of the waves, for by a proper arrangement of the selector I may derive a current or currents corresponding to any desired point or points in the electromotive-force waves, while preventing the flow of current at other points in the wave.

The tube E is what is commonly called a "single-focus" tube and may be of any desired construction, the one shown comprising a cup-shaped cathode E′ and a flat anode E^2. For regulating the vacuum of the tube a shunt E^3, having an air-gap or other resistance, is placed around the tube.

To reduce the secondary current, a resistance R is placed in series with one of the secondary leads, consisting of a rubber tube filled with water and having plugs at the ends in which the terminals are mounted. The resistance can be varied by changing the length and diameter of the tube.

It will be seen that the current passing through the tube E is always in the same direction and flows at instants when the potential in the circuit is at a maximum; also, that the discharge takes place across the air-gaps between the arms and the terminals, all of which are favorable to the production of X-rays in large quantities.

It will be understood that the resistance R is for the purpose of preventing the secondary current rising to too high a value. It is not at all necessary if the secondary winding D has of itself a sufficiently high resistance. It may also be dispensed with if the transforming apparatus has the property which tends to make the secondary current of constant amount, as when considerable magnetic leakage occurs between the primary and secondary winding. The resistance R when used might be made of any very high resisting material which would tend to diminish the current.

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

1. In an alternating-current rectifier or selector, the combination of a set of stationary contacts, a set of moving contacts, and an air-gap that is constantly maintained between the two sets of contacts, the resistance of which varies with the movement of the contacts.

2. The combination of an alternating-current source of supply, a synchronous electric motor connected therewith, and a selector apparatus having terminals connected to the circuit, and other rotary terminals driven by the synchronous motor and separated from the first at all times by an air-gap for varying the resistance of the air-gap so that current flows through the selector only during a certain fraction of the electromotive-force waves.

3. The combination of an alternating-current source of supply developing alternating electromotive-force waves in an electric circuit, with a selector apparatus comprising moving and stationary contacts which are separated at all times by an air-gap whose function is to permit the flow of current through the selector at a certain point in each alternating electromotive-force wave and prevent current-flow at other points in the wave.

4. In an alternating-current rectifier or selector, the combination of a set of stationary contacts with a set of moving contacts separated therefrom at all times by an air-gap, and the relation of the parts being such that at predetermined intervals the air-gap is reduced to a point where current will pass between the stationary and moving contacts and complete the circuit.

5. The combination, of alternating-current-supply mains, a transformer-primary connected across the mains, a secondary having an

air-gap in series therewith, a synchronous motor receiving current from the supply-mains, and a set of moving contacts driven by the motor for varying the air-gap in the secondary circuit.

6. The combination with an X-ray tube, of alternating-current-supply mains, a step-up transformer having its primary connected to the supply-mains and its secondary to the tube, a variable air-gap in series with the tube, a synchronous motor receiving its energy from the supply-mains, stationary contacts connected to the secondary circuit, and moving contacts driven by the motor so arranged that they rotate in front of, but not in contact with, the stationary contacts, for governing the flow of current in the secondary circuit.

7. The combination with a Roentgen-ray tube, of a transformer the secondary of which is employed to excite the tube, a synchronous motor, stationary contacts connected to the exciting-circuit, insulated arms normally out of circuit and driven by the motor for momentarily forming a bridge between the stationary terminals, and an air-space between the arms and stationary contacts.

8. The combination of alternating-current-supply mains, a step-up transformer connected across the mains, an X-ray tube included in the secondary circuit, and a rectifier in the secondary circuit, comprising stationary and moving contacts separated at all times by an air-gap.

9. In combination, means for producing periodic alternating waves of electromotive force, an air-gap included in circuit therewith, and means for increasing and decreasing the resistance of the air-gap in synchronism with the rise and fall of electromotive waves, in such manner that a flow of current is permitted at certain points in the electromotive waves.

10. The combination, of alternating-current mains, a transformer primary connected across the mains, a secondary connected to the translating device having a variable air-gap in series therewith, a motor operating in synchronism with the alternations in the supply-mains, and a set of contacts driven by the motor for varying said air-gap.

11. In combination, a source of alternating-current supply, a translating device, a selector included in circuit with the source of supply and the translating device, and comprising stationary and moving contacts which are separated at all times by an air-gap, and a resistance for limiting the current supplied to the translating device.

12. In combination, a primary winding, a secondary winding in inductive relation thereto, a translating device receiving current from the secondary, a selector included in circuit with the secondary, comprising fixed and moving contacts which are separated by a variable air-gap, and means for limiting the amount of current supplied to the translating device.

13. In an apparatus for obtaining direct-current impulses from a high-tension alternating-current source, the combination of the source, fixed conductors in circuit with that source, a movable conductor coöperating with the fixed conductors to form sparking gaps and means operated by the current source for moving the movable conductor away from the fixed conductors synchronously with the alternating-current waves.

14. In an apparatus for obtaining direct-current impulses from a high-tension alternating-current source, the combination of the source, a plurality of fixed conductors in circuit with that source, a plurality of movable conductors coöperating with the fixed conductors to form sparking gaps and means operated by the current source for moving the movable conductors simultaneously away from the fixed conductors synchronously with the alternating-current waves.

In witness whereof I have hereunto set my hand this 29th day of November, 1897.

HERMANN LEMP.

Witnesses:
O. F. PERSSON,
JOHN W. GIBBONEY.