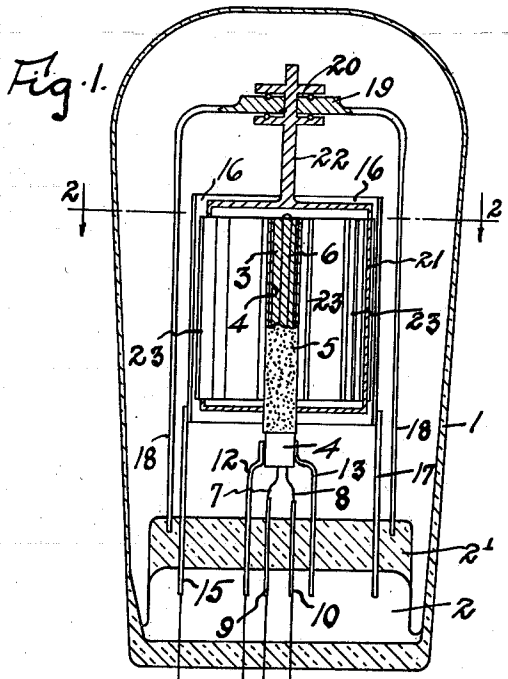
Jan. 12, 1937. A. B. DU MONT 2,067,382

SYNCHRONOUS ELECTRON MOTOR

Original Filed Jan. 31, 1930

Fig. 1.



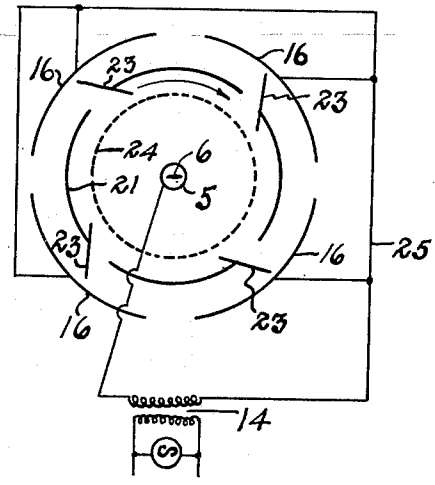


Fig. 3.

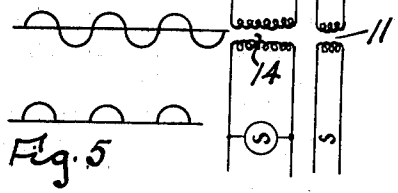


Fig. 5.

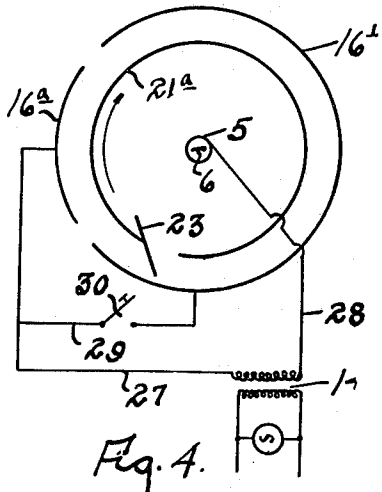


Fig. 4.

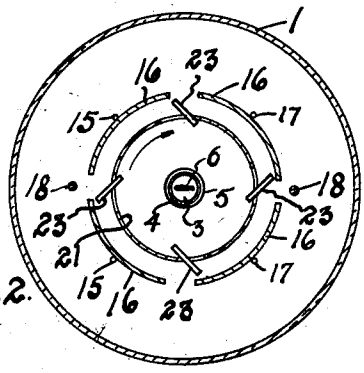


Fig. 2.

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UNITED STATES PATENT OFFICE

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SYNCHRONOUS ELECTRON MOTOR

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Original application January 31, 1930, Serial No. 425,025. Divided and this application March 25, 1935, Serial No. 12,854

9 Claims. (Cl. 172—36)

This invention relates to space discharge devices, and with particularity to means for utilizing electronic or ionic streams for operating a movable or rotatable member at synchronous speed with respect to the frequency of the energizing source.

The device of this invention is a motor which derives its motive power mainly from the kinetic energy of moving electron particles which are generated from an electron emitter surface and caused to travel at high velocity towards and strike a movable member under the influence of an electrode maintained at a positive potential with respect to the motor surface. In this device the construction is such that when energized by alternating current the movable member is caused to operate at synchronous speed.

The invention consists of many other objects which are obtained by means of the structure disclosed in full detail below.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, all as will be fully set forth in the following specification in conjunction with the attached drawing and pointed out in the appended claims.

This application is a division of my copending application Serial No. 425,025, filed January 31, 1930 issued as Patent No. 1,999,407 and dated April 30, 1935.

In the drawing,

Figure 1 is a combined vertical cross-sectional view and side elevational view of one form of device in accordance with this invention;

Fig. 2 is a cross-sectional view taken at the plane 2—2 of Figure 1;

Fig. 3 is a diagrammatic illustration of the circuit connections employed to attain the object of this invention;

Fig. 4 is a diagrammatic view of a slightly modified arrangement in accordance with the principles of this invention;

Fig. 5 illustrates curves representing the rectifying action of the movable member or rotor.

Referring to Figs. 1 and 2, the device comprises an evacuated envelope 1 of any desired shape and configuration to serve as an enclosure for the other parts of the mechanism. While the envelope is shown as having the shape usually employed for audions, it will be understood that any other shape particularly adapted for the purpose may be employed. The envelope is provided with a reentrant stem 2 having a press 2' in which the various elements of the combination are mounted. At the center of the device is the cathode comprising a tubular or rod like body 3 of insulating material having a pair of longitudinal bores extending entirely therethrough. This rod 3 is enclosed within a metal bore or sleeve 4 upon the surface of which is applied a coating 5 of any well known material capable of emitting large quantities of electrons when heated. Mounted within the bores of the rod is the heater or filament 6 by means of which the electron surface is rendered active. As will be apparent to those skilled in the art, this construction exemplifies one well known form of indirectly heated cathode structure. It is of course apparent to those skilled in the art that any equivalent cathode structure may be employed without departure from the scope of this invention.

The ends 7 and 8 of the heater 6 are connected respectively to the lead-in wires 9 and 10 which are sealed in the press 2' and which are connected to the terminals of the secondary of a transformer 11 energized from any suitable alternating current source. The cathode assembly is supported from the press by means of the rods or wires 12 and 13 which are likewise sealed in the press. At 16 are illustrated four plate-like members of arcuate cross section lying substantially upon the circumference of a cylinder concentric with the cathode assembly. These plates 16 are comparable to the anode of the usual audion, and are supported from the press by means of rods 15 and 17 which are sealed therein. As will be pointed out later, the four plates 16 are electrically connected together, and by means of one of the supporting rods 15 to the secondary of a transformer which supplies an alternating current potential to the plates. The other terminal of the secondary of this transformer is connected by a wire to the support 12 which in turn is electrically, as well as mechanically connected to the cathode sleeve 4.

Likewise sealed in the press 2' are a pair of supporting rods or standards 18 which are joined at their upper ends by means of a bearing plate 19 which provides a rotatable support for the ball bearing 20 of the vertical shaft 22. Shaft 22 is connected to the cylindrical rotor 21 which is provided with four equally spaced vanes 23 at one edge of the openings or windows in the rotor. These vanes 23 are preferably at an angle of 45 degrees with a radius from the center of the cathode.

The circuit connections for this device are more clearly illustrated in Fig. 3. The anodes or plates 16 are connected by wire 25 to one terminal of the secondary of the energizing transformer 14 and

the other terminal of which is connected to the cathode sleeve.

When a suitable potential is applied from the transformer 14 to the plates 16 so that they are at a higher positive potential with respect to the cathode and the heater 6 is energized so that the cathode surface is active, radial streams of electrons are given off from the surface 5 which move with increasing velocity towards the anodes or plates 16. Many of these electrons in seeking to reach the anodes impinge upon the surfaces of the vanes 23, thereby imparting rotation to the rotor 21 which supports the vanes. Since the power derived is dependent upon the number of electrons emitted in a unit of time, and also upon their velocity it is preferred to employ a cathode having a large active emitting area and to impress a high potential upon the anodes 16. Where the device is to be operated as a power electron discharge the envelope 1 will be evacuated to a very low pressure such as ordinarily employed in present day audions and similar space discharge devices. It will be understood, however, that it is in accordance with this invention to employ a gas or vapor filling within the envelope such as mercury vapor, so as to increase the number of electrical particles striking the vanes.

By reason of the construction above described, and the use of alternating current as the energizing source for the anodes, the rotor moves at synchronous speed. Assuming that the current of the source has the form illustrated in the upper curve of Fig. 5 and a frequency of 60 cycles per second, it will be apparent that as soon as the rotor comes up to speed it will operate it synchronously. Since the current flow through the device is in one direction only, namely from the cathode to the anodes, only the positive half waves, as indicated in the lower curve of Fig. 5, are utilized to project the electrons against the vanes 23 and consequently each positive half wave will tend to get each of the slots or windows opposite to one of the sector units 16. Thus, in the example illustrated, where four anodes and four circuits are employed, the motor will run synchronously at 900 R. P. M., assuming a 60 cycle alternating current energizing source for the anode segments. While any desired width may be given to the windows in the rotor, it is preferable to make them of the same angular width and likewise the anode segments of the same angular width. The relationship may then be expressed generally that if there are "*n*" windows and "*n*" anode segments and F is the frequency in cycles per minute of the energizing source, then the rotor member will revolve at

$$\frac{F}{n} \text{ R. P. M.}$$

At this point it may be noted, as will be apparent to those skilled in the art, that the use of four anode segments and four windows is only by way of illustration since their numbers may be varied in accordance with known principles to cause the rotation of the rotor synchronously at other speeds.

This principle has been illustrated in the diagram of Figure 4 where there are but two anode segments 16′ and 16ª, and where the rotor 21ª has but one window and one vane 23. In this case the similar segment 16ª is connected by wire 27 to one terminal of the secondary 14 and the other terminal of which is connected by wire 28 to the cathode. With a device of this nature it is necessary to provide some form of starting means for bringing the rotor up to synchronism. This is illustrated by means of the wire 29 including a normally open switch 30 which connects wire 27 to anode 16′. When switch 30 is closed both anodes 16′ and 16ª are energized from the alternating current source and the motor is then enabled to quickly come up to speed in accordance with known principles. As soon as it reaches synchronous speed switch 30 may be opened and the motor will then continue to run at synchronism, because every time anode 16ª becomes positive, the rush of electrons to it from the cathode strike the vane 23 imparting impacts to the rotor in synchronism with the frequency of the energizing source.

While Fig. 4 shows a single phase and single anode motor, it will be understood that the principle of connecting all of the anode sectors together applies to any other arrangement as illustrated for example in Fig. 3. Likewise for starting purpose an additional set of anode sectors may be provided between the sectors 16 which latter sectors are only switched into circuit during the starting of the motor.

The velocity of the electrons from the cathode towards the anodes may be increased in accordance with well known principles by the introduction of a control grid 24 between the cathode of the rotor as illustrated in Fig. 3. In accordance with known principles in the operation of audions the control electrode may be maintained at a potential positive with respect to the cathode whereby the velocity of the electrons may be increased.

From the above description it will be apparent that this invention resides in certain principles of construction and operation which may be embodied in other physical forms without departure from the scope of the invention. I do not, therefore, desire to be strictly limited to the disclosure as given for purposes of illustration, but rather to the scope of the appended claims.

What I seek to secure by United States Letters Patent is:

1. In combination an electron emitting cathode, a rotor to be rotated by emitted electrons, means for causing said rotor to rotate under control of said electrons, and means for controlling the starting of said rotor.

2. A synchronous electron motor comprising a container, an electron emitting cathode, a plurality of anodes surrounding said cathode, a rotor interposed between the cathode emitter and the anodes, means for energizing the cathode emitter, and means for impressing alternating current potentials upon said anodes whereby the rotor is operated at synchronism.

3. A synchronous electron motor comprising a container, an electron emitting cathode, a plurality of anodes surrounding said cathode, a rotor interposed between the cathode emitter and the anodes, means for energizing the cathode emitter, means for impressing alternating current potentials upon said anodes whereby the rotor is operated at synchronism, and means for bringing the rotor up to synchronous speed.

4. A synchronous electron motive device comprising an envelope, a cathode emitter mounted within said envelope, a plurality of anodes surrounding said cathode emitter, a rotor interposed between the cathode emitter and the anodes, and means for impressing an alternating current potential upon the anodes.

5. A synchronous electron motive device com-

prising an envelope, a cathode emitter mounted within said envelope, a plurality of anodes surrounding said cathode emitter, a rotor interposed between the cathode emitter and the anodes, means for impressing an alternating current potential upon the anodes, and means for connecting all of the anodes together for starting and bringing the rotor up to synchronous speed.

6. A synchronous electron motor comprising an envelope having a low pressure therein, a cathode emitter within the envelope, means for heating said emitter, a plurality of anodes surrounding said emitter, a rotor rotatably supported between the emitter and the anodes, and means for impressing an alternating current potential upon the anodes.

7. A synchronous electron motor comprising an evacuated envelope, a cathode emitter within said envelope, an anode within said envelope, a rotor supported between the anode and the cathode, means for applying an alternating current potential to the anode whereby electrons traveling from the cathode to the anode strike the rotor and cause it to revolve at synchronous speed, another anode, and means for applying an alternating current potential to said second anode during starting.

8. A synchronous electron motor comprising an envelope, a cathode emitter within the envelope, a plurality of anodes surrounding said emitter, an apertured rotor supported between the emitter and the anodes, vanes mounted on the rotor at the apertures, and means for applying an alternating potential to the anodes.

9. A synchronous motor comprising an envelope, a cathode emitter within the envelope, an anode, a rotor positioned between the cathode and the anode, means for applying an alternating current potential between the cathode and the anode, an auxiliary electrode and means for positively biasing the auxiliary anode with respect to the cathode during starting of the motor.

ALLEN B. DU MONT.