March 10, 1936. A. F. POOLE 2,033,899

ELECTRIC CLOCK

Filed June 16, 1931

Fig. 1

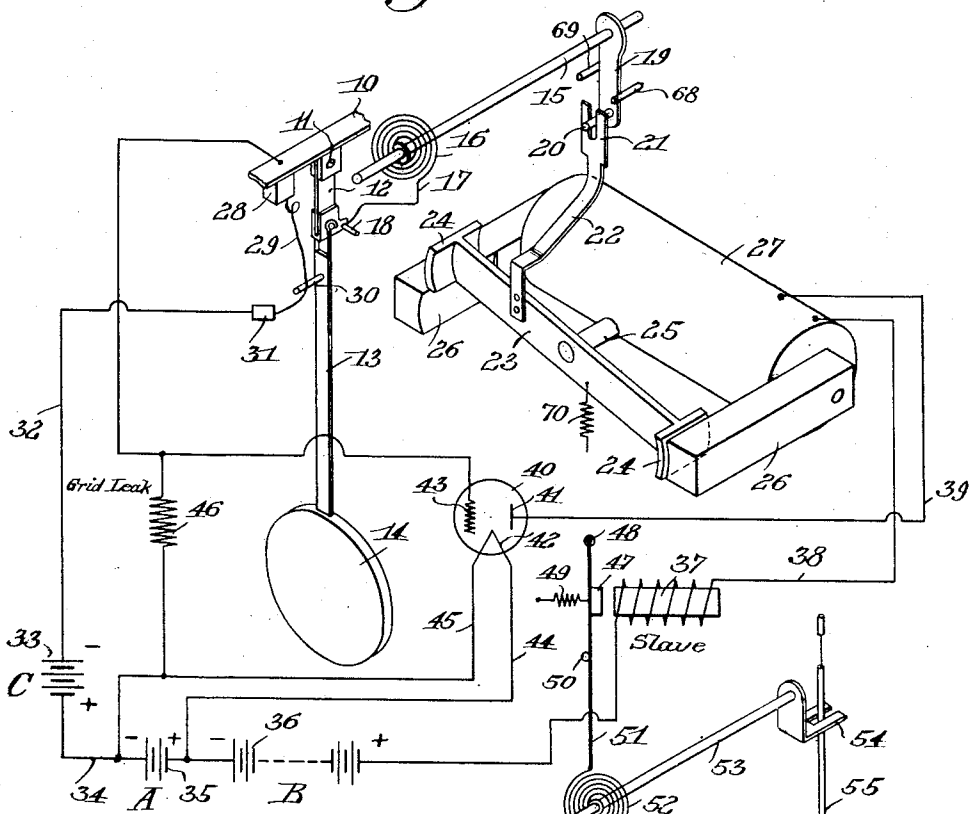
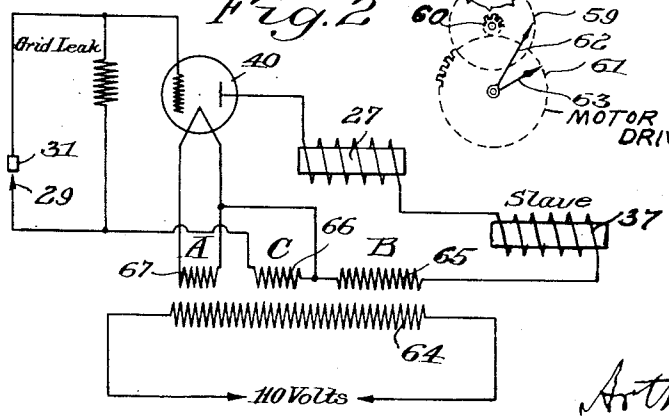


Fig. 2



INVENTOR

Arthur F. Poole

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ELECTRIC CLOCK

Arthur F. Poole, Ithaca, N. Y.; Maryline B. Poole, administratrix of said Arthur F. Poole, deceased, assignor to Maryline B. Poole, Ithaca, N. Y.

Application June 16, 1931, Serial No. 544,839

11 Claims. (Cl. 58—29)

My invention is an electric clock. One of the objects of my invention is the provision of a vibrating pendulum which is periodically maintained by an improved impulse device to the end that the impulse needed to replenish the energy dissipated by the pendulum since it last received an impulse, is given without friction to the pendulum.

Another object of my invention is the provision of an improved contact making device which shall require a minimum of energy for its application. A further object of my invention is the provision of electro-magnetic means to give an impulse to the pendulum, said means being controlled by a trigger circuit to the end that the current made and broken by said trigger circuit is infinitesimal compared to the current required to operate said electro-magnetic means.

Another object of my invention is the provision of a free pendulum and a slave pendulum kept in synchronism therewith, all the work of moving the clock hands being done by the slave to the end that the free pendulum shall be undisturbed in its natural period.

Another object of my invention is an improved synchronizing device to keep two vibrating bodies in phase with each other.

Another object of my invention is the use of an improved relay to govern the electro-magnetic means used in my herein described clock, in particular the use of a triode valve and its associated circuits for said purpose.

The above and other objects of my invention will be apparent to those skilled in the art from the following specification and claims.

Referring now to the drawing, Fig. 1 is a more or less diagrammatic view of my improved free pendulum and slave clock and Fig. 2 is an alternative circuit to that shown in Fig. 1. Like parts have the same number in both figures.

In Fig. 1, 10 is the framework of the free pendulum and serves to support a stud 11 in which is the suspension spring 12 on which is the pendulum rod 13 on which is the bob 14. The bob 14 is provided with a suitable adjusting nut (not shown) to regulate the pendulum to the desired rate. Rotating in the framework is a shaft 15 on which is mounted an impulse spring 16 having one end attached to the shaft 15. The other end 17 of the impulse spring is bent towards the pendulum and is held by a pin 18 in the lower end of the suspension spring 12. Mounted on the end of the shaft 15 and rigid therewith is a crank 19 in which is mounted a pin 20 engaged by a fork 21 in the end of an arm 22 mounted on an armature 23 turning in the framework 10 on a shaft 25. The armature 23 has enlarged ends 24 which are adapted to be attracted by the pole pieces 26 when current is sent through the magnet 27 which is mounted in the framework 10. The ends 24 are turned to an arc of a circle about the shaft 25 and the co-operating surfaces of the pole pieces 26 are bored to a slightly larger circle about the same shaft to the end that the armature may be attracted between the pole pieces without shock or noise. A retractile spring 70 serves to hold the armature 23 in a position determined by a stop 68 co-operating with the crank 19 and a stop 69 also acting on the crank 19 serves to determine the attracted position of the armature 23.

From what has been described it is apparent that when current is sent through the magnet 23, the shaft 15 will be rotated in a clockwise direction and when the magnet 27 is de-energized the retractile spring 70 will rotate the shaft 15 in a counter clockwise direction. I will now describe the circuit connections whereby the vibration of the pendulum 13 results in the exciting and de-energizing of the magnet 27 corresponding to the to and fro motion of the pendulum whereby the pendulum is maintained by the winding and unwinding of the impulse spring 16.

In the framework 10 is a stud 28 to which is attached a contact wire 29 having a tension to make it touch a contact point 31 insulated from the frame work. A pin 30 is mounted in the pendulum 13 and is positioned to engage the spring 29 and lift it out of contact with the insulated point 31 when the pendulum swings to the right. The contact arrangement just described is connected with the negative pole of a battery 33 by the wire 32, and thus controls the plate current of a triode tube 40 having the customary grid 43, filament 42 and plate 41. An A battery 35 is connected by the conductors 44 and 45 to the filament 42 and the positive side of the B battery 36 is connected by wire to the slave magnet 37 (afterwards to be described) and then by a wire 38 through the magnet 27 to the plate 41. The battery 33 is so chosen to put sufficient negative bias in the grid to block the plate current when the contact 29—31 is closed. When said contact is open the plate current energizes the magnets 37 and 27 with the result that their armatures are drawn up.

Before describing the operation of the free pendulum 13, I will first describe the structure of the slave clock since the operation of this clock is tied up with and dependent on the operation of the free pendulum. The function of the slave

clock is to keep count of the number of vibrations of the free pendulum, and do all the work such as moving the clock hands. To this end I have provided a second or auxiliary pendulum which is driven by means independent of the free pendulum and which drives or governs the clock hands, but which, by novel synchronizing means, is kept swinging in unison with the free pendulum so that the hands of the slave clock indicate the time kept by the free pendulum.

Referring again to Fig. 1, an ordinary clock train, which may consist in part of a center wheel 61 gearing the third wheel pinion 60 on a third wheel 59 which drives a pinion 58 on a scapewheel 57, is provided. The scapewheel 57 actuates a pallet 56 mounted on a shaft 53 on which is a fork 54 which drives the slave pendulum 55 which is regulated by regulating nut (not shown) to keep approximately the same time as the free pendulum 13. The slave clock may be wound by any convenient means, preferably an electric wind of some kind although it may be wound by hand if desired. The slave clock is kept in step with the free pendulum by a spring 52 fastened to the shaft 53 and having the outside end move to and fro by a lever 51 turning on a pivot in the framework at 48 and held by a retractile spring 49 against a stop 50. An armature 47 is on the lever 51 and is actuated by the slave magnet 37. As previously described, the slave magnet 37 is in circuit with the magnet 27 and is energized simultaneously therewith, from which it results that the lever 51 moves the end of the spring 52 in step with the swings of the pendulum 13. This motion of the spring 52 will hold the slave 55 in step with the free pendulum 13 and the hands 62 and 63 will show the time of the free pendulum. The above means of synchronization I have found very effectual; its simplicity speaks for itself.

From what has been said the operation of my clock will be clear to those skilled in the art. Starting with the parts in the position shown in Fig. 1, the armatures 23 and 47 in their retracted positions, the contact 31 closed and the arm 19 resting against the stop 68, the pendulum swings to the right, breaking the contact 31 by reason of the pin 30 lifting the wire 29 therefrom. This, as before explained, removes the negative bias from the grid 43 and plate current flows through the magnets 27 and 37 which draw up their armatures. This results in the shaft 15 being rotated in a clockwise direction giving a slight impulse to the pendulum 13, and correspondingly the lever 51 gives a small synchronizing impulse to the slave 55. The pendulum 13 continues to swing to the right until it reaches the end of its arc, when it starts to return to the left. When it reaches the middle of its arc, the pin 30 permits the wire 29 to make contact with the contact 31, thus throwing a negative bias on the grid 40. This cuts off the plate current which has been holding the armatures of the magnets 27 and 37 and their armatures are retracted, the shaft 15 is given a counter clockwise rotation again giving a slight impulse to the pendulum 13 and the spring 52 gives a corresponding synchronizing impulse to the pendulum 55. The pendulum continues its swing to the left, reaches the end of its arc and returns to the right to the position shown in Fig. 1. This completes the cycle of operation.

It will be observed that the pendulum 13 is free except for the work of moving the wire 29, and as to this practically no energy is lost, for while the pendulum 13 does work on the wire when it swings to the left the wire does an equal amount of work on the pendulum when the pendulum swings to the right. The only loss is the friction between the wire 29 and the pin 30. This is negligible from two causes. First the wire is very small, in practice I make the wire 29 of silver of a diameter of 3/1000 inch and give a tension just enough to make it touch the contact point 31: second, the spring flexes from a point in line with the point of flexure of the suspension spring, so there is practically no sliding between the wire 29 and the pin 30. I am able to use this light contact between the wire 29 and the contact 31 by reason of the electric circuit I employ. The current broken at 31 is on the order of a few micro-amperes and there is no induction spark. A resistance of 100,000 ohms may be inserted in the grid circuit 32 without materially changing the cut off of the plate current; it is a voltage condition which determines this cut off, not an amperage one.

The free pendulum has the desirable merit of working up its arc from a very small one, if the pendulum is given an initial swing of a few minutes of arc, just enough to make a clean break of the contact 31, it will work itself up to its equilibrium arc as determined by the tension of the spring 16. In practice I prefer to use a week spring for 16 and throw it through a large angle rather than use a strong spring 16 and wind it through a small angle. The spring 16 is fastened to the shaft 15 by friction and may be rotated to change its tension and thus give the free pendulum 13 any desired arc.

In Fig. 2 I have shown an alternative circuit which will be clear without extended explanation. The batteries A, B and C of Fig. 1 are replaced by a transformer having a primary winding 64 placed in circuit with 110 volt A. C. current supply. Secondary winding 65, 66 and 67 furnish current for the plate grid bias and filament respectively. Some slight displacement of the phase results from the inductance of the magnets 27 and 37; however this is not enough to interfere with the working of the circuit, and use of a commercial A. C. current makes a convenient source.

While I have shown an escapement type of clock for the slave clock, this is by no means necessary, a pendulum actuated clock such for example as shown in my Patent #1,756,437 April 29, 1930 will answer very well. Further I may point out that by making the spring 52 of the slave clock strong enough, said spring will actuate the pendulum 55 without the aid of the escapement and also keeps said pendulum in step with the free pendulum; in this case the pendulum 55 would be provided with a feeding device such as shown in my cited patent to feed the clock hands. However I prefer a slave clock which has its own source of power: it will then take care of itself during a short interruption of the synchronizing current. For less accurate work than required for a precision clock the slave clock may be omitted and a feed pawl placed on the armature 23. This pawl would feed a count wheel suitably geared to clock hands. However this arrangement would have the fault that whenever the current was momentarily interrupted the count wheel would stop and the hands would accordingly be slow the time the current was off. Whether or not such an arrangement would be good enough would depend on the particular use to which the clock was put. I have not described such a feed from the armature since the arrangement is well known to those skilled in the art. One arrangement suitable for the purpose is shown in my patent cited above.

Many variations may be made in the structure herein shown without departing from the spirit of my invention, since I claim:—

1. In an electric clock the combination of a pendulum, a rocker, an impulse spring having one end fastened to the pendulum and the other end fastened to the rocker, stops delimiting the motion of the rocker, an electromagnet adapted to move said rocker from contact with one stop into contact with the other and means including a contact device operated by the pendulum independent of the impulse spring to control when the action of said electromagnet shall take place.

2. In an electric clock the combination of a pendulum, a rocker, an impulse spring having one end fastened to the pendulum and the other end fastened to the rocker, stops delimiting the motion of the rocker, an electromagnet adapted to move said rocker from contact with one stop into contact with the other, means including a contact device operated by said pendulum to control when said electromagnet shall act and a pin on said pendulum to open and close said contact device.

3. In an electric clock the combination of a vibrating member, an impulse mechanism acting on said member to keep it in vibration, an electromagnet, a source of periodic currents whose frequency is independent of that of the vibrating member adapted to excite said electromagnet, an armature operated by said electromagnet and a spring attached at one end to said member and at the other end to said armature.

4. In an electric clock the combination of a pendulum, a rocker, a spring attached at one end to said pendulum and at the other end to said rocker, a triode having a plate and a grid, a plate circuit for said triode, an electromagnet in said plate circuit, means to actuate said rocker operated by said magnet, a grid circuit for said triode and means including a circuit breaking device actuated by said pendulum in said grid circuit.

5. In an electric clock the combination of a pendulum, a rocker, a spring having one end fastened to said pendulum and the other end to said rocker and adapted to be flexed periodically by said rocker to keep said pendulum in vibration, a vacuum tube, an electro-magnet actuating said rocker and in the plate circuit of said tube, a contact device and grid leak in the grid circuit of said tube and an arm on said pendulum to operate said contact device.

6. In an electric clock the combination of a pendulum, a rocker, a spring having one end attached to said rocker and the other end to said pendulum, said spring being adapted to be flexed periodically by said rocker to maintain said pendulum in vibration, electromagnetic means to operate said rocker, a second means controlling the action of said electromagnetic means, said second means including a contact device, a triode, an electric circuit including said triode and said electromagnetic means, a second circuit including said triode and said contact device, and an arm on said pendulum to operate said contact device.

7. In an electric clock the combination of a pendulum, a rocker, an impulse spring having one end attached to said rocker and the other to said pendulum, an electromagnet adapted to operate said rocker, means including a contact device to energize said electromagnet and an arm on said pendulum to operate said contact device whereby said spring is flexed synchronously with the swing of said pendulum.

8. In a clock the combination of a vibrating member, a synchronizing spring having one end attached to said vibrating member, means attached to the other end of said spring adapted to displace the same, means to maintain said vibrating member in vibration and means to displace said first mentioned means periodically and independent of the frequency of said vibrating member whereby said member is kept in step with the frequency of said displacing means.

9. In an electric clock the combination of a pendulum, impulse means attached thereto, a triode having a plate and a grid, electric circuits for said plate and grid, an electromagnet connected in the plate circuit of said triode and adapted to flex said impulse means and a contact device operated by said pendulum in the grid circuit of said triode.

10. In an electric clock the combination of a pendulum, mechanical means to give an impulse thereto to maintain said pendulum in vibration, a triode having plate and grid circuits associated therewith, means to store energy in said mechanical means in the plate circuit of said triode, means including a contact device in the grid circuit of said triode to actuate said energy storing means coincident with the operation of said contact and means actuated by said pendulum to operate said contact.

11. In an electric clock the combination of a pendulum, mechanical means to give an impulse thereto to maintain said pendulum in vibration, a triode having plate and grid circuits associated therewith, an electromagnet adapted to store energy in said mechanical means in the plate circuit of said triode, means including a contact in the grid circuit of said triode to actuate said electromagnet and an arm on said pendulum to actuate said contact.

ARTHUR F. POOLE.