Aug. 8, 1961 R. L. BOYLES 2,995,005

SIMULATED SWINGING PENDULUM CLOCK

Filed May 21, 1959 3 Sheets-Sheet 1

Fig. 1.

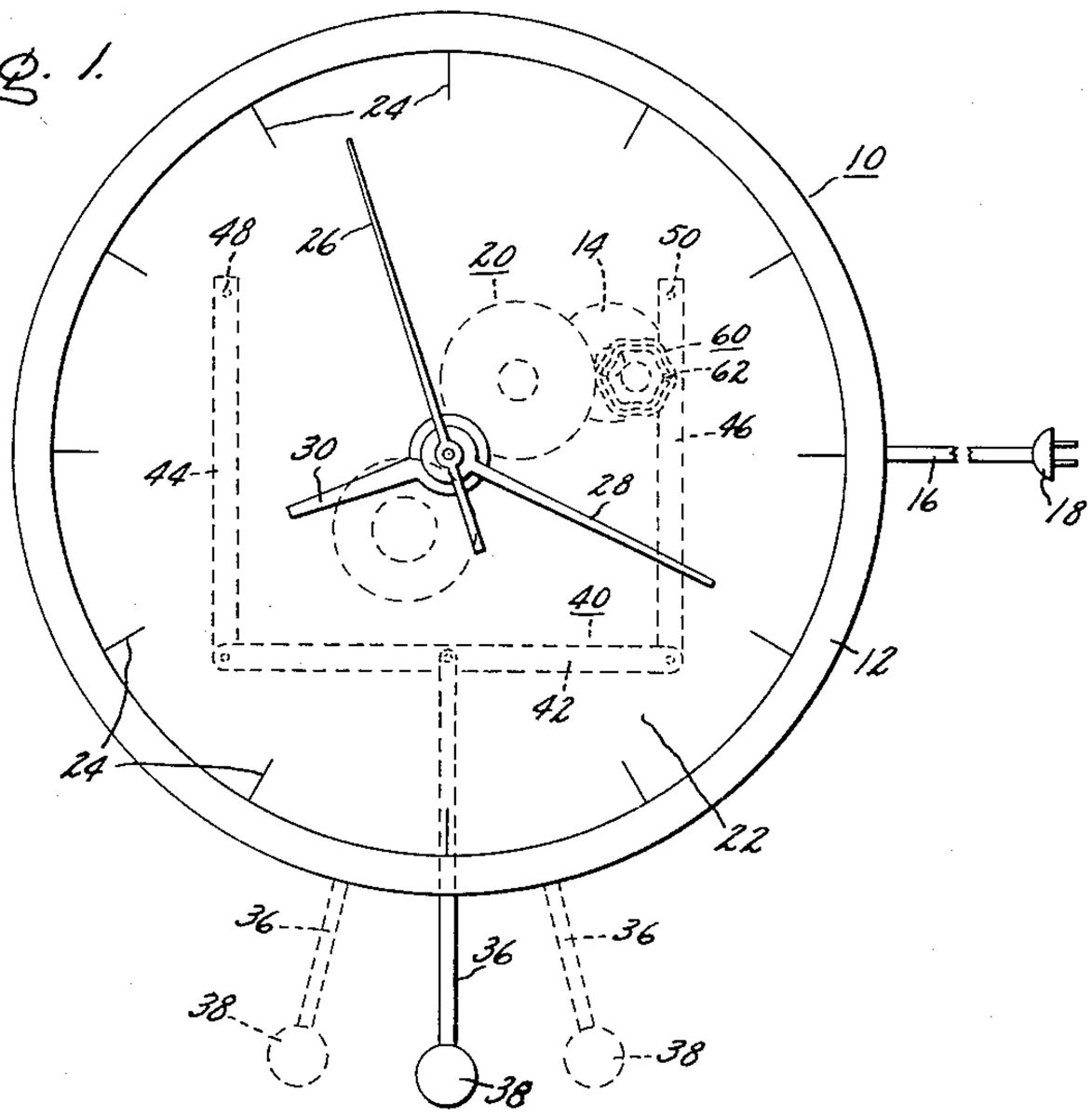


Fig. 4.

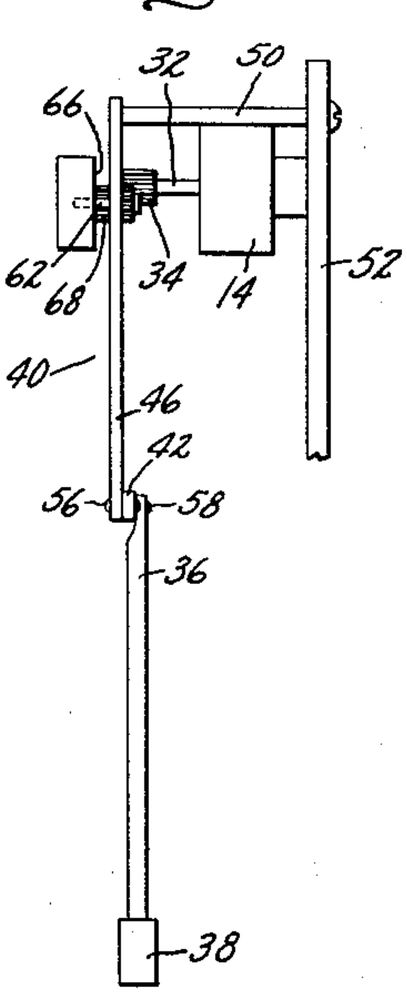
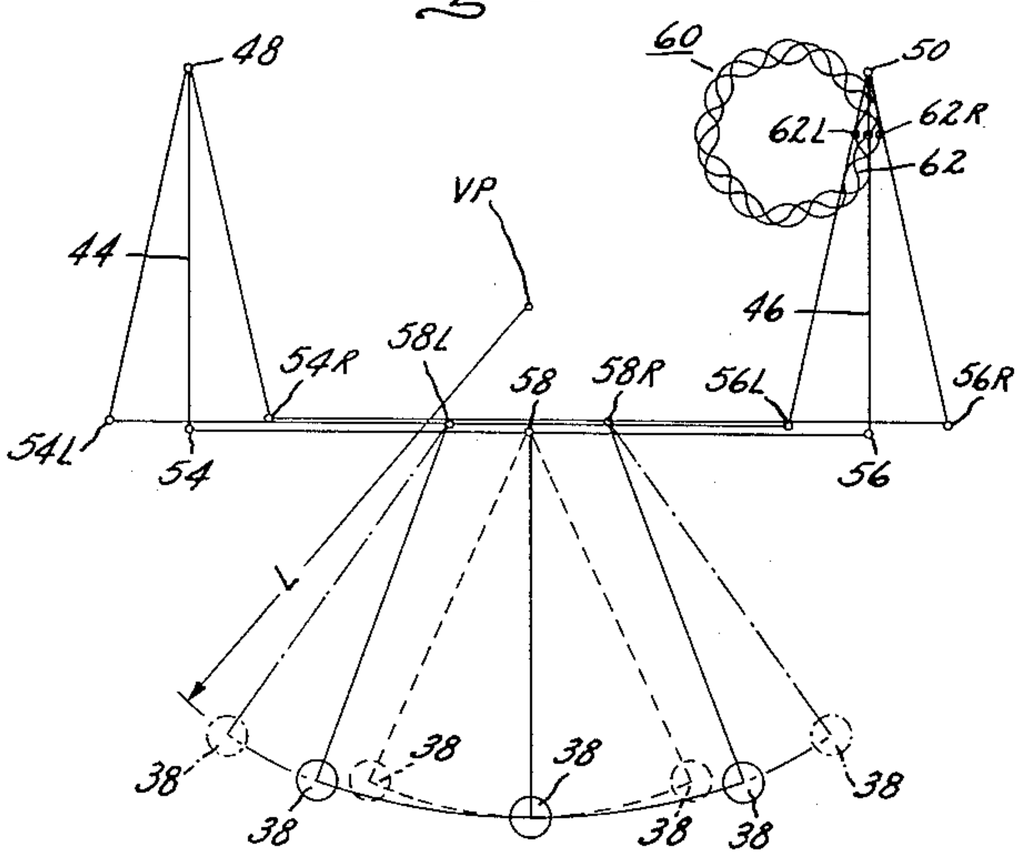


Fig. 8.



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Aug. 8, 1961 R. L. BOYLES 2,995,005

SIMULATED SWINGING PENDULUM CLOCK

Filed May 21, 1959 3 Sheets-Sheet 2

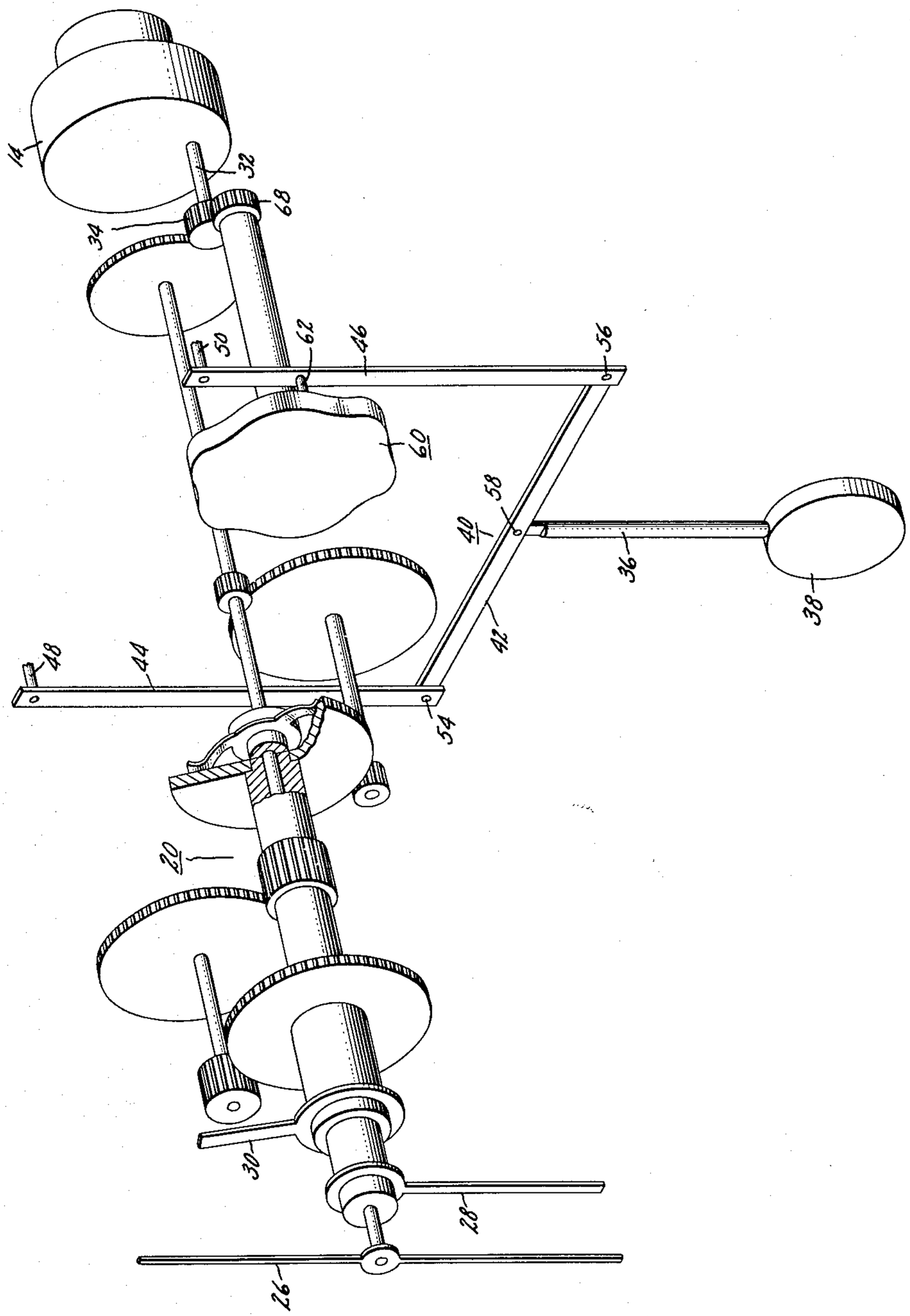

Fig. 2.

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Aug. 8, 1961 R. L. BOYLES 2,995,005

SIMULATED SWINGING PENDULUM CLOCK

Filed May 21, 1959 3 Sheets-Sheet 3

Fig. 3.

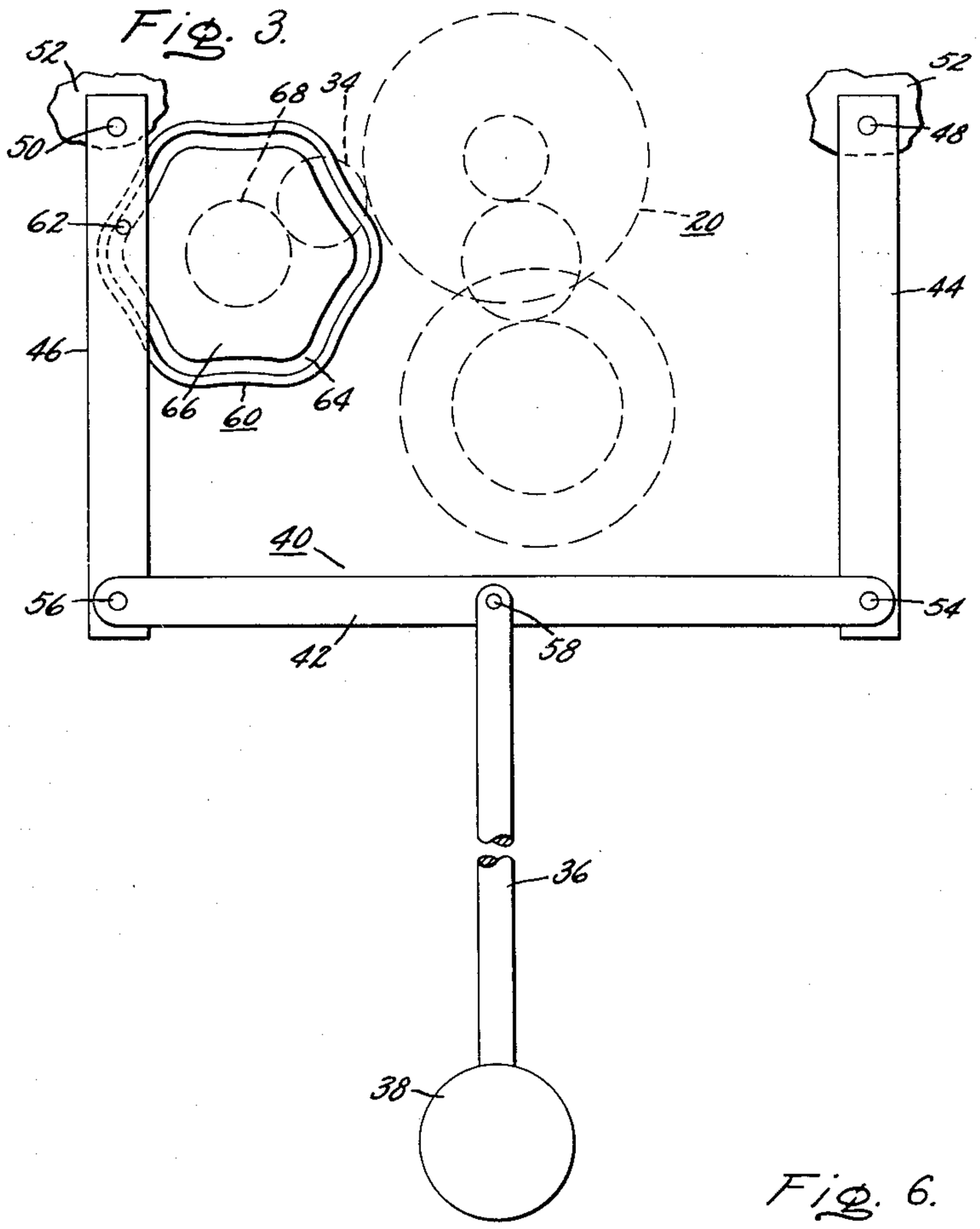


Fig. 5.

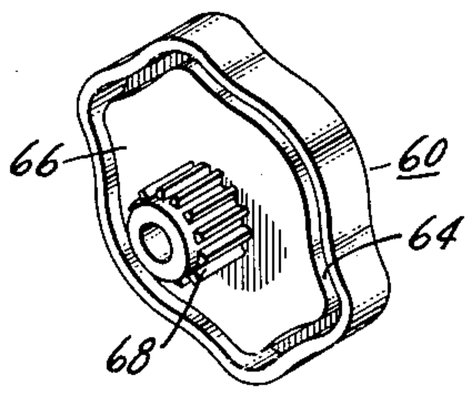


Fig. 6.

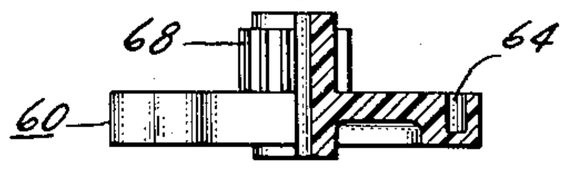
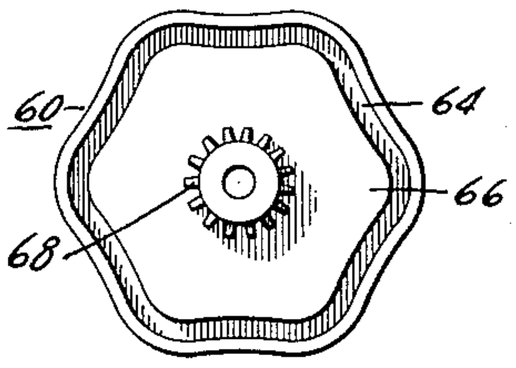


Fig. 7.



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United States Patent Office

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SIMULATED SWINGING PENDULUM CLOCK

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Filed May 21, 1959, Ser. No. 814,748
17 Claims. (Cl. 58—26)

This invention relates to clocks and to clock mechanisms, and particularly to electric clock mechanisms which include a simulated swinging pendulum, the pendulum motion of which is utilized for other than timekeeping purposes and does not control the operation of the clock mechanism.

Most contemporary clocks are electrically operated and include a synchronous electric motor for driving the indicating hands through appropriate reduction gearing. Although the clocks are entirely satisfactory for the functional purpose of keeping time, the clock industry, being highly competitive, has attempted to add attractive features to these clocks to increase their sales appeal. This has led to the present stress in the clock industry on artistically designed ornamental casings for the clock mechanisms. The old-fashioned swinging pendulum clocks, grandfather, mantel and the like, wherein the pendulum was structurally integrated into the clock mechanism and performed a timekeeping function, are still considered by the clock industry to be asthetically appealing to a significant number of people. Therefore, the clock industry has striven to provide a clock having the appearance and apparent external operation of an old-fashioned swinging pendulum clock and yet which possesses the inherent advantages of a synchronous electric motor driven clock.

A general object of this invention is to provide an improved synchronous electric motor driven clock mechanism which includes a simulated swinging pendulum which is functionally independent of the timekeeping portion of the clock mechanism and which does not perform a timekeeping function.

A particular object of this invention is to provide an improved swinging pendulum mounting and pendulum driving arrangement in a simulated swinging pendulum clock mechanism of the type set forth in the preceding paragraph.

The objects of my invention are achieved by incorporating into a synchronous electric motor driven clock mechanism, a swinging pendulum, at least the bob of which is visible from the exterior of the clock casing, and a unique mounting and driving arrangement therefor.

The above and other objects and further details of that which I believe to be novel and my invention will be clear from the following description and claims taken with the accompanying drawings, wherein:

FIG. 1 is a front elevational view of an electric clock which incorporates my invention;

FIG. 2 is an enlarged exploded view of the clock mechanism thereof and the improved swinging pendulum and its mounting and driving arrangement;

FIG. 3 is an enlarged rear elevational view of the improved pendulum, mounting and driving arrangement;

FIG. 4 is an enlarged side elevational view of the improved pendulum, mounting and driving arrangement looking from the right in FIG. 1;

FIGS. 5, 6 and 7 are, respectively, a rear perspective view, a side elevational view with portions broken away and shown in section and a rear elevational view of the driving cam which forms a part of the pendulum driving arrangement, and

FIG. 8 is a schematic illustration of the operation of the pendulum, its mounting and its driving arrangement.

By reference to the drawings, and particularly to FIG. 1, the clock is generally indicated by reference numeral

10 and illustrated as having an ornamental casing 12 which houses most of the operating clock mechanism and is capable of being hung from a wall. It will be understood that the casing may be designed for wall, mantel or floor mounting and be of any ornamental design. The illustrated clock is a preferred embodiment of my invention and is of the electrically operated type. It contains clock mechanism including a synchronous electric motor 14, to which alternating electrical current is supplied by a conventional electrical cord 16 having a male electrical connector plug 18 for connection to a domestic electrical outlet, a gear reduction train 20, a face 22 having suitable time indicating indicia 24 thereon and second, minute and hour hands 26, 28 and 30, respectively, which are coaxially mounted. The clock 10 includes additional unillustrated conventional structure, such as manual control rods, to render it complete and operative as is well understood in the art. For an understanding of the preferred embodiment of the instant invention, it is simply necessary to know that the motor 14 includes a main driving shaft 32 which rigidly supports main driving pinion 34, which is rotated by the motor at a constant speed, and that pinion 34 drives the gear reduction train 20, which can most clearly be seen in FIG. 2 and may be of known construction and operation, to ultimately drive hands 26, 28 and 30 at their desired rates of speed to perform conventional timekeeping and indicating functions.

The foregoing known structure may be considered to be the setting in the preferred embodiment of my invention for the unique pendulum, mounting and driving arrangement therefor which I have devised, and which renders such a known electric clock readily adaptable to simulate the appearance and apparent operation of a swinging pendulum clock. The pendulum is illustrated as comprising a rod 36 which is generally vertically extending, rigidly supports a bob 38 at its lower end and is pivotally secured at its upper end to the pendulum mounting means designated generally as 40. It will be observed that the pendulum rod 36 has its upper portion disposed within the casing 12 whereas its lower end extends below the casing through an aperture (not shown) to the exterior thereof where it and the bob 38 are visible from the exterior of the casing.

The pendulum mounting means 40 comprises a generally U-shaped suspension for supporting the pendulum for swinging, and comprises the elongated suspension bar 42 and the elongated arms 44 and 46. The arms 44 and 46 are individually pivotally mounted at their upper ends about pivot pins 48 and 50, respectively, which in turn are rigidly secured to the clock mechanism supporting frame 52. The arms 44 and 46 are individually pivotally secured at their lower ends to opposite ends of bar 42 by pivot pins 54 and 56, respectively. The U-shaped suspension may be conveniently disposed in casing 12 along with much of the clock mechanism and when at rest is symmetrical, and the bar 42 is horizontally extending and the arms 44 and 46 are spaced, parallel, vertically extending and perpendicular to the bar 42. It will, therefore, be observed that the U-shaped suspension, because of its pivotal mounting means, is capable of swinging laterally in the plane of the U if an external lateral force is exerted on it. During such swinging, the arms 44 and 46 oscillate about fixed pivot pins 48 and 50, respectively, the arms remaining parallel at all times, and the bar 42 moves horizontally to-and-fro so that a point thereon moves in a slightly arcuate manner.

The upper end of the pendulum rod 36 is pivotally connected to an intermediate portion of bar 42 by the pivot pin 58, and therefore is capable of swinging about the pivot pin 58 in the same general plane of the U-shaped suspension. In addition to such normal swinging, the pendulum is capable of enhanced and magnified

swinging by virtue of its being mounted on a horizontally shifting pivot, which results when the U-shaped suspension swings laterally as described above. This will become more apparent when the overall operation of the pendulum, its mounting means and its driving means are subsequently set forth.

The driving means for the pendulum comprises means for steadily causing the U-shaped suspension to swing laterally to-and-fro. This is effected by causing one of the elongated arms, as illustrated arm **46**, to function as a driving arm by forceably causing it to oscillate about its pivot pin **50**. Such oscillation may be caused in any desired manner; in the illustrated embodiment of the invention it is caused by utilizing a driving cam **60** and cam follower pin **62**, and forming a circular sinusoidal groove **64** in the driving face **66** of the cam, rigidly securing the follower pin on the driving arm **46**, and disposing the follower pin in the groove. The driving cam **60** is driven at a constant speed by the motor **14**, as by meshing the motor driving pinion **34** with a pinion **68** formed on the cam face side of driving cam **60**. It will, therefore, be apparent that rotation of the driving cam **60** causes the follower pin **62** and the driving arm **46** to oscillate about pivot pin **50**, as a result of the cooperative action of the groove **64** and follower pin **62**, and this produces transverse swinging of the entire U-shaped suspension. The latter causes the pendulum to pivot about pivot pin **58**, and due to the horizontal shifting of the pivot pin **58**, the normal swing of the pendulum about pivot **58**, if the pivot point were fixed, is altered and the pendulum actually has a greater amplitude than it normally would have had, a somewhat flatter arc, particularly at the central portion of the arc, and moves somewhat faster. It should be clearly understood that although the driving cam **60** preferably has a sinusoidal groove, that it is not imperative that the groove be "truly" sinusoidal, and that, in general, equivalent types of cams, such as zig-zag, wavy, and to-and-fro cams could be substituted for the described cam arrangement. However, the described cam arrangement has been found in practice to operate smoothly and quietly.

FIG. 8 schematically illustrates the operation of the pendulum. If the pendulum were caused to swing about fixed pivot point **58** with its mounting means at rest, its bob **38** would describe the dotted line arc. However, as a result of the lateral swing of the U-shaped suspension, the bob **38** describes the solid line arc. The terminal portions of the latter swing are slightly more curved and are indicated by the terminal dot-dash arc portions, but the central portion thereof is flatter.

In FIG. 8 it will also be seen that the follower pin **62** is caused by the cam **60** to oscillate between a left-hand position **62L** and a right-hand position **62R**. The oscillation of the follower pin is accompanied by oscillation of the driving arm **46** and is translated thereby into substantially magnified horizontal to-and-fro movement of the suspension bar **42**, as evidenced by the movement of any fixed point thereon, such as pivot points **54**, **56** and **58**, which oscillate in arcs **54L—54R**, **56L—56R**, and **58L—58R**, respectively, which are greater than arc **62L—62R** of the follower pin **62**.

Therefore, the driving means forces the follower pin **62** and driving arm **46** to oscillate at a fixed frequency, and the mounting means causes this movement to be magnified and utilized at locations which are convenient and desirable for pivotally supporting the pendulum, as at the location of pivot pin **58**. The pivot pin **58** is the point of free swinging suspension of the pendulum, and therefore, the driving means causes the pendulum to swing, by swinging the suspension bar to-and-fro, and it also causes the pendulum's point of suspension to oscillate horizontally between **58L** and **58R**, and this results in alternation of the normal free swing of the pendulum and results in a fast, wide, flat swing of the pendulum, which is visually dramatic, and therefore desirable.

The altered pendulum swing approximates the free swing of a pendulum having a longer length (L) than the actual length (A.L.) of the pendulum rod **36**, and creates the visual impression that the pendulum is pivoting about an imaginary pivot point (V.P.) which may be called the "virtual" pivot point of the pendulum, that is located above the actual pendulum pivot point **58**.

The theory of the foregoing operation is as follows: A free swinging pendulum operates at its natural frequency as determined by its length. The driving arm **46** is forced to oscillate at a fixed frequency, and therefore, the pendulum must accommodate itself to this fixed frequency by apparently swinging about a virtual pivot point whose location is such that the pendulum has an apparent length having a natural frequency that corresponds to the driving arm's fixed frequency. The pendulum automatically selects the proper virtual pivot point by automatically selecting the proper amplitude of swing. The motion of the pendulum bob may not be a precise arc, but this is not of practical visual importance.

By referring to FIG. 8, it will be observed that for any given driving arm frequency, if the actual pendulum length (A.L.) were shortened, the virtual pivot point (V.P.) would move above illustrated point (V.P.) and the amplitude would be less. If the actual pendulum length (A.L.) is increased, the virtual pivot point lowers. I have found that if the virtual pivot point is too close to the actual pivot point **58** of pendulum suspension, excessive amplitude and unstable operation results. Therefore, the most desirable mode of operation is produced by providing for the virtual pivot point to be disposed substantially above the actual pivot point **58** of pendulum suspension. This most desirable mode of operation can be effected by providing a pendulum having an actual length corresponding to a frequency that is substantially higher than the fixed frequency of the driving arm, for this will insure that the virtual pivot point is disposed substantially above the actual pivot point of the pendulum. With the foregoing in mind, the proper combination of driving arm frequency and pendulum length may be provided to produce a pendulum having a swing that satisfies the desired styling requirements and which has stable, quiet operation.

It should be noted that my improved pendulum, mounting and driving arrangement possesses numerous advantages, including the following: The driving means may be formed of small components and conveniently located within the clock casing without interfering with the existing parts, and the pendulum may be conveniently located elsewhere and still have the desired swinging motion and in apparent point of suspension near the center of the clock, which is desirable from the standpoint of styling and rate of oscillation. The driving means can be driven by the same motor that drives the clock mechanism, because its power requirements are small due to the "free" action of the pendulum, rather than "forced" action, and consequently the pendulum's requiring only enough power to overcome gear and pivot friction and windage losses. However, a separate motor may be employed for the driving means if preferred. Also, the arrangement will function as a tell-tale to indicate if the clock motor is running, if the pendulum driving means is driven by the clock motor. Furthermore, the pendulum operates with little noise and can readily be modified to provide other pendulum amplitudes to accommodate various styling requirements. Lastly, the pendulum does not have to be "tuned" accurately, and therefore, ordinary manufacturing tolerances do not adversely affect its operation materially.

As will be evident from the foregoing description, certain aspects of my invention are not limited to the particular details of construction of the example illustrated, and I contemplate that various and other modifications and applications will occur to those skilled in the art. It is, therefore, my intention that the appended claims shall

cover such modifications and applications as do not depart from the true spirit and scope of the invention.

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

1. An electric clock comprising: a casing; a clock mechanism including a synchronous electric driving motor; a pendulum; means for mounting said pendulum for swinging movement; and means for driving said pendulum; said pendulum having portions extending vertically downwardly, said mounting means including an elongated suspension bar which extends generally horizontally and which is mounted for generally horizontal displacement in a to-and-fro manner along lines generally parallel to the length of the bar, said pendulum at its upper end being pivoted to said suspension bar intermediate its ends, whereby it moves generally horizontally to-and-fro when said suspension bar moves generally horizontally to-and-fro, and said driving means being arranged to cause movement of said suspension bar generally horizontally to-and-fro.

2. An electric clock as defined in claim 1 wherein said motor actuates said driving means.

3. An electric clock as defined in claim 1 wherein said mounting means further includes a pair of spaced parallel arms, each of which is pivotally mounted at one of its ends about a fixed pivot point and pivotally mounted at the other of its ends to an opposite end of said suspension bar, and said arms are disposed perpendicularly to said suspension bar when said mounting means is at rest whereby said arms and said bar generally form a U.

4. An electric clock as defined in claim 3 wherein said driving means moves said suspension bar by causing one of said arms to oscillate.

5. An electric clock as defined in claim 4 wherein said one of said arms oscillates at a fixed frequency and said pendulum is pivotally supported by said suspension bar and of a length to have a natural frequency which is higher than said fixed frequency.

6. An electric clock as defined in claim 4 wherein said driving means comprises a rotatable cam that is driven at a constant speed and which has a cam portion which is operatively associated with said one of said arms to translate rotation of said cam into oscillation of said arm.

7. An electric clock as defined in claim 6 wherein said cam portion comprises a circular substantially sinusoidal groove and said one of said arms rigidly supports a follower pin which rides in said groove whereby rotation of said cam is translated into oscillation of said one of said arms by said groove and pin arrangement.

8. A clock comprising: a casing; a clock mechanism; a pendulum; means within said casing for mounting said pendulum for swinging movement; and means within said casing for driving said pendulum; said mounting means comprising a pair of suspension arms and a suspension bar, said arms being spaced, parallel and vertically extending, said arms being pivotally mounted at their upper ends about pivot supports which are rigidly fixed relative to said casing and pivotally secured at their lower ends to the opposite ends of said bar, which extends generally horizontally to connect the lower ends of said arms and thereby form a U, said pendulum being pivoted at its upper end by said bar intermediate its ends and having its lower end extending to the exterior of said casing, and said driving means being arranged to oscillate one of said arms to thereby move said bar generally horizontally to-and-fro along lines generally parallel to the length of the bar and cause said pendulum to move to-and-fro.

9. A clock as defined in claim 8 wherein said one of said arms oscillates at a fixed frequency and said pendulum is pivotally supported by said suspension bar and of a length to have a natural frequency which is higher than said fixed frequency.

10. A clock as defined in claim 8 wherein said pendulum is pivotally secured to said bar.

11. A clock as defined in claim 8 wherein said clock mechanism is driven by a synchronous electric motor.

12. A clock as defined in claim 11 wherein said motor actuates said driving means.

13. A clock as defined in claim 8 wherein said driving means comprises a rotatably mounted cam which is driven at a constant speed and which has a cam portion which is operatively associated with said one of said arms to translate rotation of said cam into oscillation of said one of said arms.

14. A clock as defined in claim 13 wherein said cam portion comprises a circular substantially sinusoidal groove and said one of said arms rigidly supports a follower pin which rides in said groove whereby rotation of said cam is translated into oscillation of said one of said arms by said groove and pin arrangement.

15. A clock as defined in claim 8 wherein said driving means is actuated by a constant speed electric motor.

16. An electric clock comprising: a casing; a clock mechanism including a synchronous electric driving motor; a pendulum; means within said casing for mounting said pendulum for swinging movement; and means within said casing for driving said pendulum; said mounting means comprising a pair of suspension arms and a suspension bar, said arms being spaced, parallel and vertically extending, said arms being pivotally mounted at their upper ends about pivot supports which are rigidly fixed relative to said casing and pivotally secured at their lower ends to the opposite ends of said bar, which extends generally horizontally to connect the lower ends of said arms and thereby form a U, said pendulum being pivotally supported at its upper end by said bar at a point intermediate of the ends of said bar and having its lower end extending to the exterior of said casing, said driving means comprising a rotatable cam that is driven at a constant speed by said motor and which includes a circular substantially sinusoidal groove, one of said arms rigidly supporting a follower pin which rides in said groove whereby rotation of said cam is translated into oscillation of said one of said arms by said groove and pin arrangement and results in generally horizontal to-and-fro movement of said bar along lines generally parallel to the length of the bar and consequent swinging of said pendulum.

17. A clock as defined in claim 16 wherein said one of said arms oscillates with a fixed frequency and said pendulum is of a length to have a natural frequency which is higher than said fixed frequency.

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