July 14, 1970 H. A. KUHN 3,520,125

PENDULUM CLOCK

Filed Jan. 22, 1969 2 Sheets-Sheet 1

FIG. 1

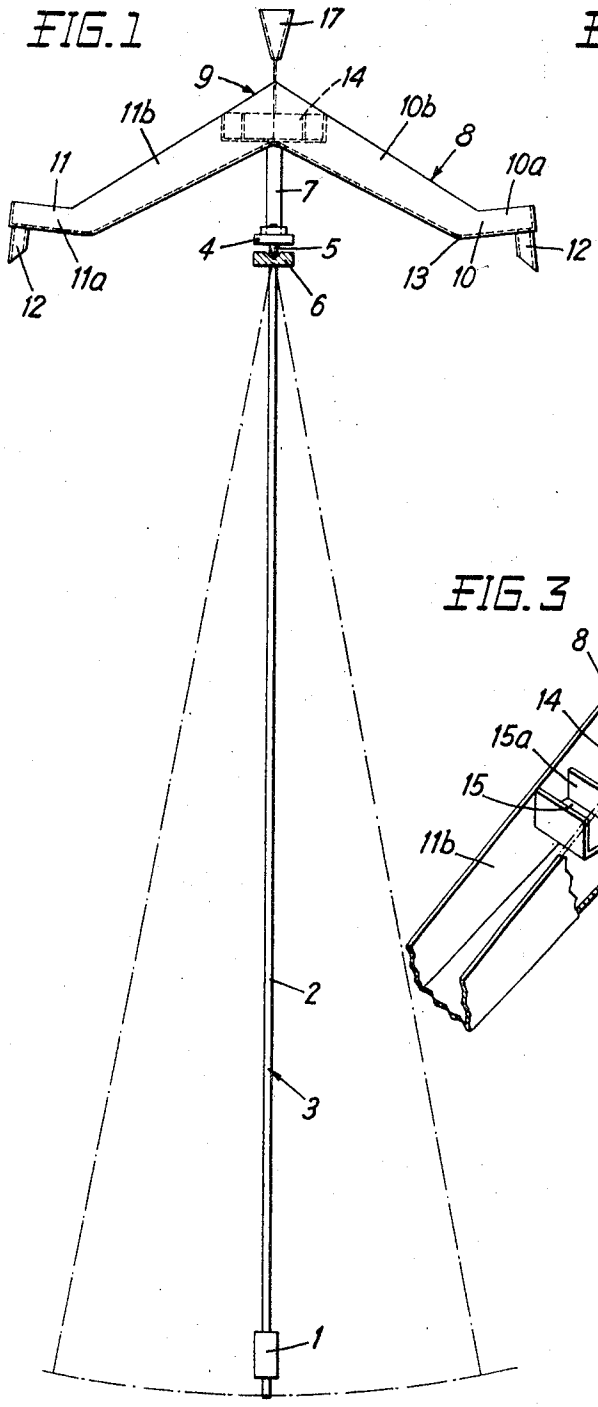


FIG. 2

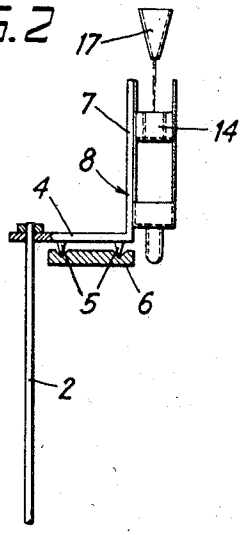
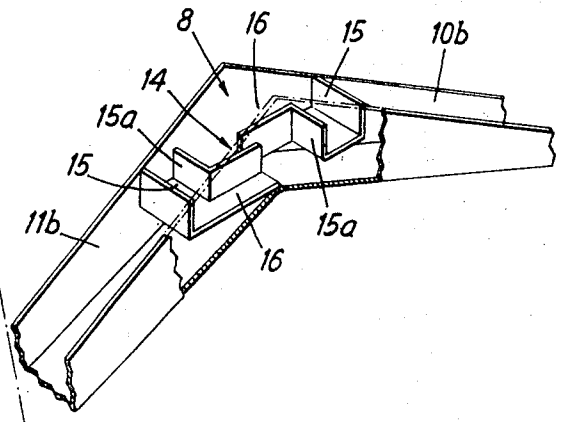


FIG. 3



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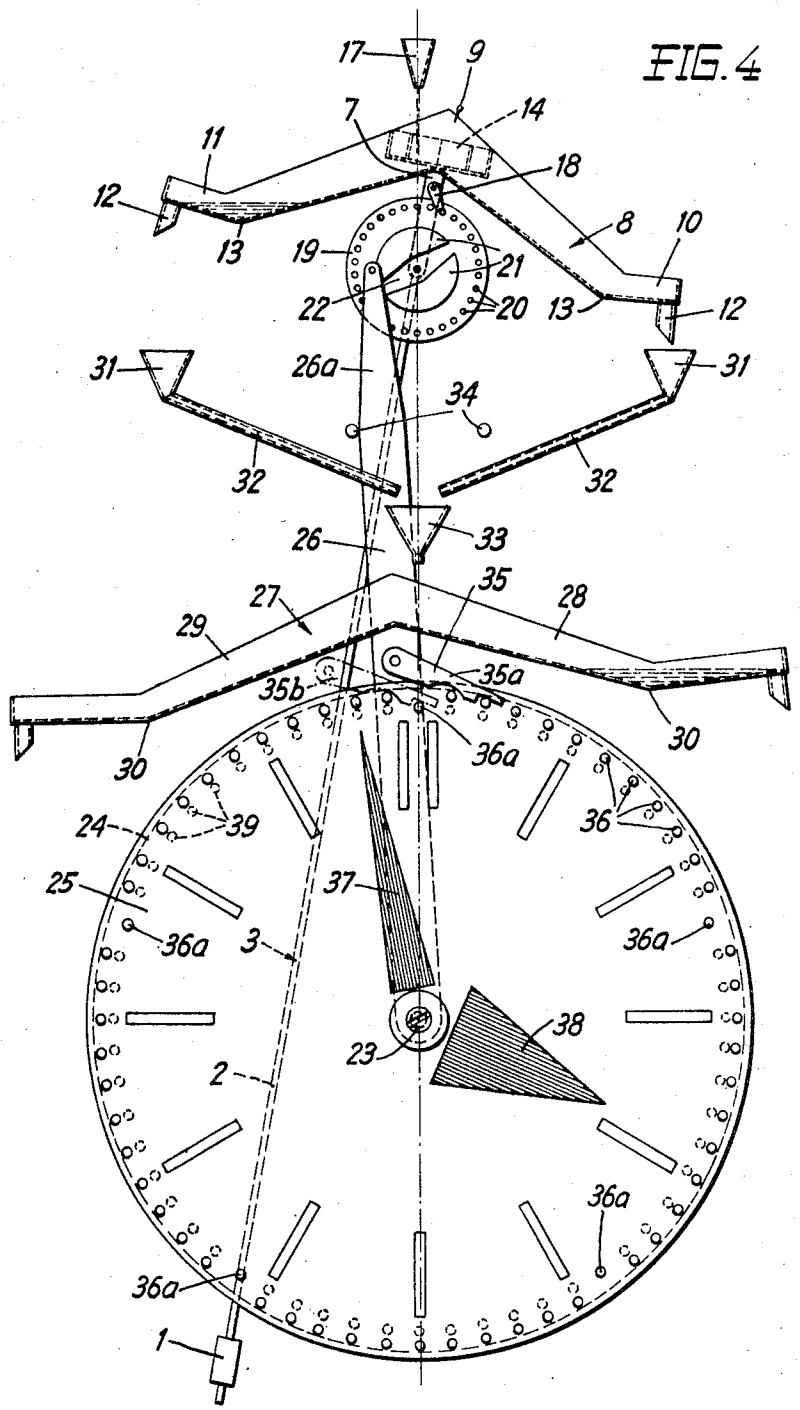
Filed Jan. 22, 1969 2 Sheets-Sheet 2

FIG. 4



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PENDULUM CLOCK

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U.S. Cl. 58—2 7 Claims

ABSTRACT OF THE DISCLOSURE

A liquid power pendulum clock is disclosed, the clock comprising a source of liquid for supplying motive power, a pivotally mounted beam member, time-indicating means controlled by the beam member, and regulator means including a pivotally mounted balance means rigidly mounted on the pendulum for controlling the beam member. The balance means includes two channel-shaped arms for receiving the liquid, each of the arms having pocket means in communication with the channel means for temporarily holding the liquid. In the extended position of the pendulum, the liquid is collected in one of the arms and discharged from the other whereby the beam member is alternatively acted upon on each side by the liquid being discharged from the balance means. The oscillation of the pendulum thus affected causes a cam-controlled drive lever to turn a minute disc and an hour wheel. A damper is provided so as to prevent the pendulum from swinging too far.

BACKGROUND OF THE INVENTION

The invention relates to a pendulum clock having a regulating organ with means for diverting liquid, and a beam alternately acted upon on each side by liquid for operating means for indicating the minutes. A pendulum clock of this kind has been described, the liquid diverting means pivoting an operating member that cooperates with two oppositely acting springs, which kept the pendulum in oscillation by alternately giving it oppositely directed impulses. The liquid diverting means also served to deliver liquid alternately to the two arms of a beam. The oscillation of this beam was transmitted by pawls to the hands of the clock and to the winding mechanism of the striking work.

The use of springs to oscillate the pendulum, particularly, but also the way in which the movement of the beam is transmitted to the hands and the winding mechanism led to a construction that was as complicated as it was filled with friction-causing parts, so that it was impossible to attain a sufficient accuracy.

SUMMARY OF THE INVENTION

The purpose of the invention is to produce a pendulum clock of the general kind described in the first paragraph of the preceding section, but which is appreciably simpler in design, yet a very exact timepiece.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in detail, with reference to the figures of the accompanying drawings, wherein:

FIG. 1 is a schematic front view of the balance, damper, and the pendulum in its center position;

FIG. 2 is a side view of a part of the pendulum;

FIG. 3 is a perspective view, partly broken away, of the damper and the central part of the balance; and

FIG. 4 is a schematic front view of the entire clock.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The pendulum **3**, comprising the bob **1** and the rod **2**, is screwed into a yoke-like member **4**, which, by means of hardened pivots **5**, is mounted free to swing on a support **6**. The front end of the member **4** carries an upright support **7**, to which is attached the beam **8**, having the arms **10** and **11**, of the balance **9**, that acts as the regulating organ together with the pendulum. Each arm **10** and **11** consists of an angled, generally U-shaped channel that is closed at its outer end, but is provided with an outlet tube **12**. Bend **13** in each arm broadly comprises a pocket means for temporarily holding liquid. The angle of the bend **13** in each arm is so chosen that when the pendulum **3** is in its center position (shown in FIG. 1), the two arm outer portions **10***a* and **11***a* incline somewhat upwards, whereas when the pendulum is at one end of its swing the arm outer portion of that arm which is lower slopes somewhat downwards. The two arm inner portions **10***b* and **11***b* are also angled with respect to each other, so that the beam **8** has rather the shape of a W; in other words, the two arm inner portions **10***b* and **11***b* slope downwards from the center of the beam; and the arm outer portions **10***a* and **11***a*, when the pendulum is in its center position, slope upwards.

The balance **9** incorporates a damping arrangement **14**, the operation of which will be described later. The arrangement comprises two transfer receptacles **15** having each an inner wall **15***a*. Each receptacle is so mounted between the two side walls, at the inner end, of a respective arm inner portion, **10***b*, **11***b* that the inner walls **15***a* of the receptacles are spaced a certain distance from each other and from the beam middle. Each transfer receptacle **15** embodies an outlet channel **16** that extends sufficiently far towards the opposite beam arm so that the liquid can flow from the receptacle into the U-shaped channel of the other arm.

An outlet **17** for liquid is located directly above the middle of the beam **8**. A thin stream of liquid, preferably water, falls down onto the beam. As with other pendulum clocks, the pendulum, at the start, must be pushed; and the drive arrangement, here the balance **9**, only serves to keep the pendulum oscillating. The dimensions of the parts are so chosen that, when the pendulum **3** is in the position shown in FIG. 4, and the amplitude of the pendulum swing is normal, the stream of water falls between the walls **15***a* of the two transfer receptacles and, corresponding to the position of the central apex of the beam **8**, the water flows down the channel of the arm **11** and collects in the bend **13**. The weight of this water exerts a counterclockwise torque on the pendulum **3**, which torque acts as an impulse to keep the pendulum swinging.

As soon as the pendulum, now swinging to the right, has passed through its center position, the water from the outlet **17** pours into the channel of the opposite arm **10**, while the arm **11** empties through the outlet tube **12**. In this way, there is obtained a torque that swings the pendulum in the other direction, and thus the latter is kept oscillating.

The upright support **7** carries a click **18** which cooperates with a drive wheel **19** that is arranged coaxially to the axis about which the pendulum **3** swings. The wheel is provided near its periphery with thirty uniformly spaced drive pins **20**. The central part of the wheel consists of two approximately crescent-shaped cams **21**, with an opening **22** therebetween, the function of which latter will be later explained.

If the period of the pendulum is two seconds, and if the drive wheel **19** each period is advanced the spacing between two successive pins **20**, the drive wheel makes one complete turn every minute.

When the excursion of the pendulum begins to increase beyond the allowed maximum, the damping arrangement comes into play, but otherwise remains inoperative as long as the amplitude is not excessive: in other words, as long as the water falls between the two walls **15***a*. But as soon as the amplitude increases beyond that which is permissible, water pours into one of the transfer receptacles **15**, from where it pours down the respective outlet channel **16** and into the channel of the lower beam arm. Since this water is necessarily transferred to the opposite arm shortly before the pendulum changes its direction of swing, this water does not have time to reach the outlet tube **12** before the pendulum starts to swing back. Consequently, this transferred water acts as a counterweight to the water collected in the bend of the other arm, and therefore reduces the torque acting to swing the pendulum. In this way, any excessive increase in the pendulum amplitude is prevented.

Cooperating with the cams **21** of the drive wheel **19** is the free end **26***a* of a drive lever **26**, which latter is mounted on the arbor **23** of the hour wheel **24** and the minute disc **25**, the latter acting as a cannon pinion. A stepping beam **27** is rigidly connected to the lever **26** and has two arms **28** and **29**, which, as those of the balance **9**, define a W and have each a bend **30** near their outer ends, in which water can collect. Two funnels **31** and respective tubes **32** collect the water from the balance arms **10** and **11** and alternately pour it into a collecting funnel **33**, which pours the water into the stepping beam **27**. The arms **28** and **29** of the latter, as do those of the balance **9**, serve to divert the water to the left or to the right, depending on the position of the drive lever **26**. In the position shown in FIG. 4, the water collects in the bend of the arm **28**, while the lever **26**, in its extreme left position, abuts against the left one of the two stop pins **34**; at the same time, a roller (not shown) which is formed by the free end **26***a* of the lever **26** is pressed against one of the two cams **21**. This relationship obtains until the wheel **19** is turned sufficiently so that the opening **22** is positioned opposite this roller, or cam follower, whereupon the water collected in the bend **30** of the arm **28** causes the lever **26** to swing clockwise until it strikes the opposite stop pin **34**, the cam follower moving through the opening **22**. The arm **29** is now positioned beneath the funnel **33** so that, once the other arm **28** is emptied of its water, a counterclockwise torque acts on the lever **26**, which torque presses the cam follower against the opposite cam **21** until—as is the case every 30 seconds—the follower is free to move through the opening **22** and the drive lever **26** can swing back.

Pivotally connected to the lever **26** is an advancing pawl **35** which cooperates with the pins **36** of the transparent cannon pinion **25** having a minute hand **37**. Sixty pins **36** are evenly distributed at an angular spacing of 6° near the periphery of the cannon pinion. Five pins **36***a* (or every twelfth one) of these sixty pins are evenly spaced along a circle having a radius smaller than that along which are located the remaining pins. Since the lever **26** makes a move every 30 seconds, the advancing pawl **35** turns the cannon pinion through a distance equal to the spacing between two successive pins **36**, or 6°, and thus the hand **37** indicates the minutes in the usual manner.

The hour wheel **24**, shown in dash line in FIG. 4, is mounted coaxially behind the transparent cannon pinion **25** and has fixed to it a hand **38** for showing the hours. The hour wheel is also provided with a circle of sixty pins **39**, the circle defined having the same radius as that defined by the pins **36***a*. The pawl **35** is constructed as a double pawl, of which the front arm **35***a* cooperates with the pins **36** and the rear arm **35***b* (shown in dash line in another pawl position) with the pins **39** of the hour wheel **24**. The consequence of this construction is that every time one of the pins **36***a* is moved to a position opposite the pawl **35**, which then swings farther downwards, the pawl also engages one of the pins **39** of the hour wheel **24**, and thus turns the latter through a distance equal to the spacing between two successive pins **39**. Since the hour wheel also has 60 pins spaced 6° apart and is advanced five times for every one complete revolution of the cannon pinion, the hour hand **38** is moved 30° every hour to indicate the hours in the usual manner. The water poured from the beam **27** can be collected in a reservoir and from there moved by a small pump to the outlet **17**.

The construction of the invention eliminates nearly all friction producing parts and produces a clock of improved accuracy with simpler design.

What is claimed is:

1. A liquid powered pendulum clock comprising: a source of liquid for supplying the motive power to said clock; a pivotally mounted beam member; time-indicating means controlled by said beam member; and regulator means including a pivotally mounted balance means rigidly mounted on said pendulum for controlling said beam member, said balance means including two channel-shaped arms for receiving said liquid, each of said arms having pocket means for temporarily holding said liquid, said pocket means being in communication with said channel means, so that in the extended position of said pendulum, said liquid is collected in one of said arms and discharged from the other whereby the beam member is alternatively acted upon on each side thereof by said liquid being discharged from said balance means.

2. A liquid powered pendulum clock as defined in claim **1**, wherein said pocket means is formed by a bend in each arm of such an angle at each end thereof such that in each end position of said pendulum, said liquid is collected in one of said arms and discharged from the other.

3. The pendulum clock as defined in claim **2**, including a damper for limiting the maximum excursion of said pendulum, said damper comprising a transfer receptacle in each said arms equally spaced from the middle of said balance means, and an outlet channel for each said transfer receptacle leading to the arm of the other said transfer receptacle.

4. The pendulum clock as defined in claim **2**, including a pivotally mounted drive lever rigidly mounted to said beam, a free end incorporated by said lever, a drive wheel moved stepwise by said balance, a cam incorporated by said drive wheel and cooperating with said lever free end to free said drive lever to pivot at regular time intervals that correspond to the time intervals shown by said minute indicating means.

5. The pendulum clock as defined in claim **4**, wherein said beam is positioned to be acted upon by the liquid furnished to said arms by said liquid supplying means, whereby the liquid acting on said beam results in a torque alternately applied to said drive lever in opposite directions.

6. The pendulum clock as defined in claim **2**, including a pivotally mounted drive lever, a pawl mounted on said drive lever, and wherein said minute indicating means is a rotatably mounted disc, and including a minute hand fixed on said disc to turn therewith, and a series of regularly spaced pins mounted on said disc near the periphery thereof and cooperating with said pawl to be moved by the latter, when said drive lever pivots to turn said disc through a predetermined arc.

7. The pendulum clock as defined in claim **6**, wherein said disc is transparent and acts as the cannon pinion, and said pins are divided into two groups spaced along respective circles of different diameters, and including an hour wheel coaxially mounted behind said disc free to turn, an hour hand fixed on said hour wheel to turn therewith, and a plurality of means incorporated by said hour wheel and located along a circle of the same radius as that of the smaller of the two circles defined by said disc pins, said hour wheel means cooperating with said

pawl to advance said hour wheel wherever said pawl co-operates with the disc pin group defining the smaller circle.

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