C. GRIVOLAS.

CLOCK PENDULUM HAVING ALTERNATING ROTARY MOVEMENT.

APPLICATION FILED FEB. 5, 1910.

991,717.

Patented May 9, 1911.

3 SHEETS—SHEET 1.

FIG-1

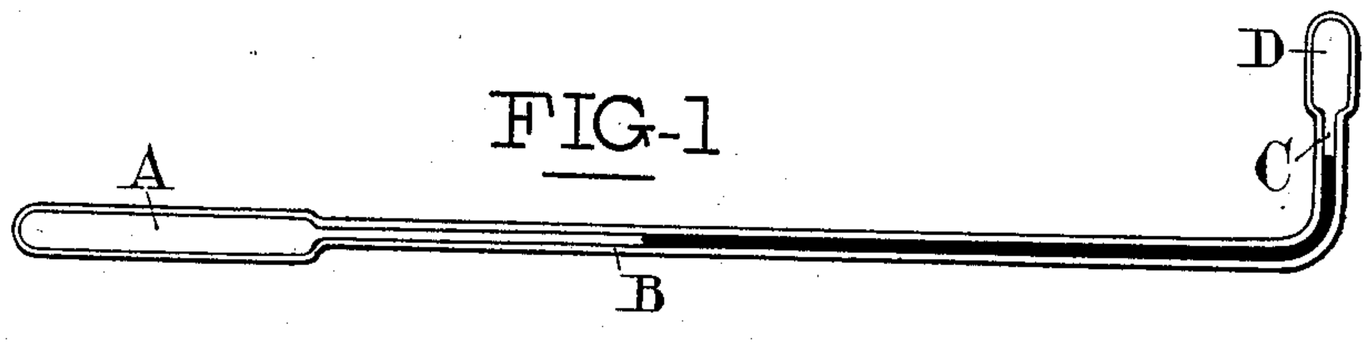


FIG-2

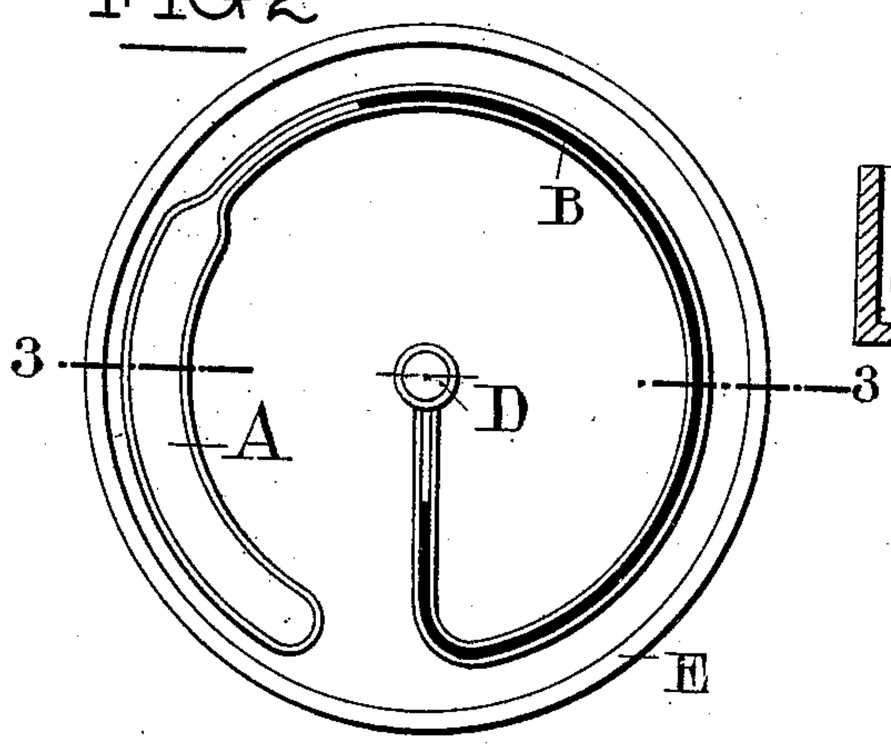


FIG-3

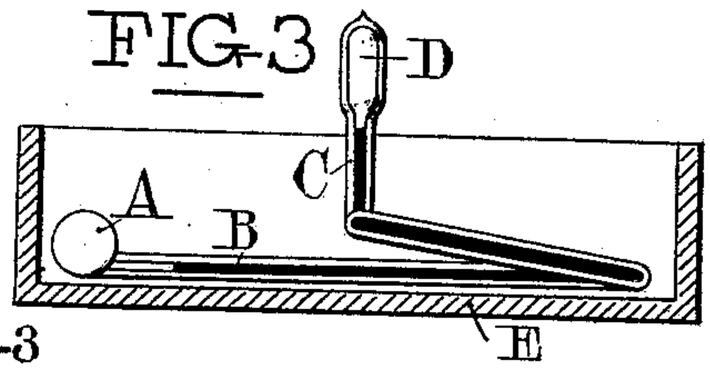


FIG-4

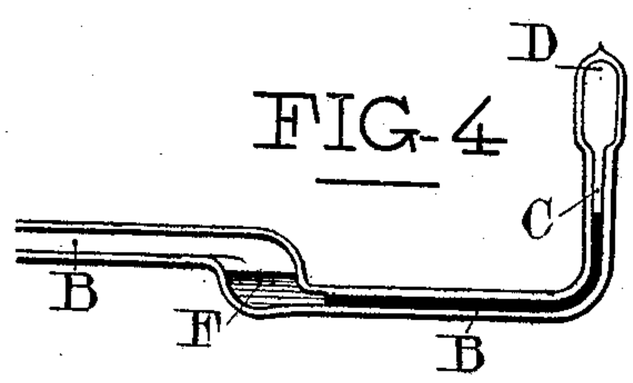


FIG-5

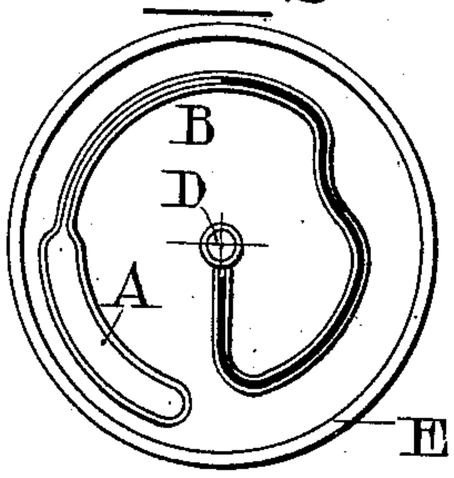


FIG-6

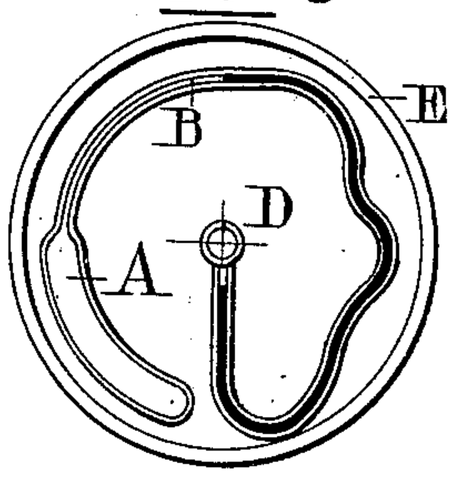


FIG-7

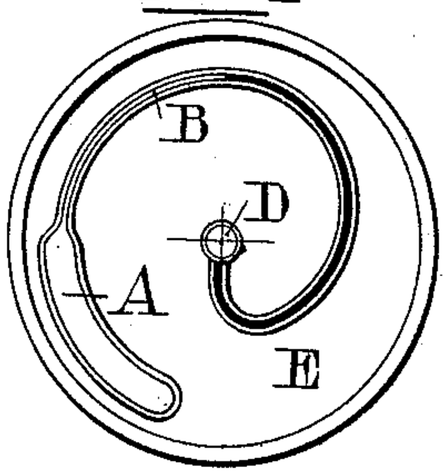


FIG-8

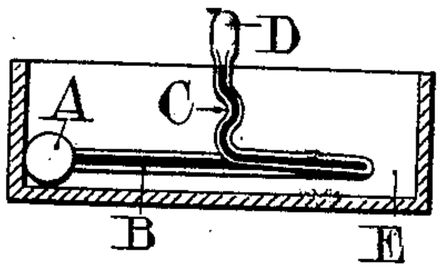


FIG-9

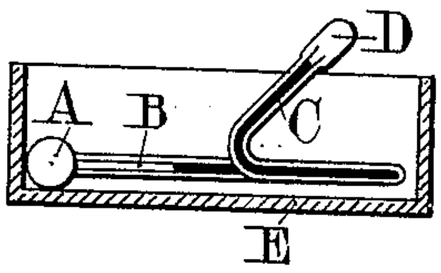
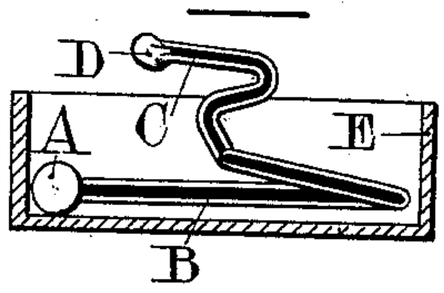


FIG-10



Witnesses:

Jean Germain

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Inventor:

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3 SHEETS—SHEET 2.

FIG-11

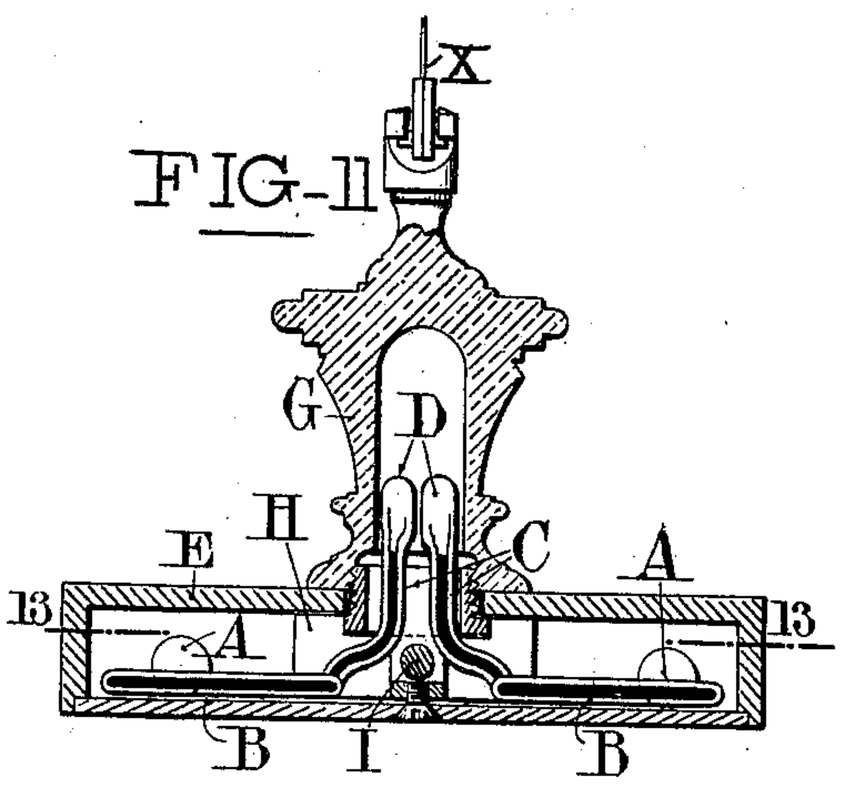


FIG-12

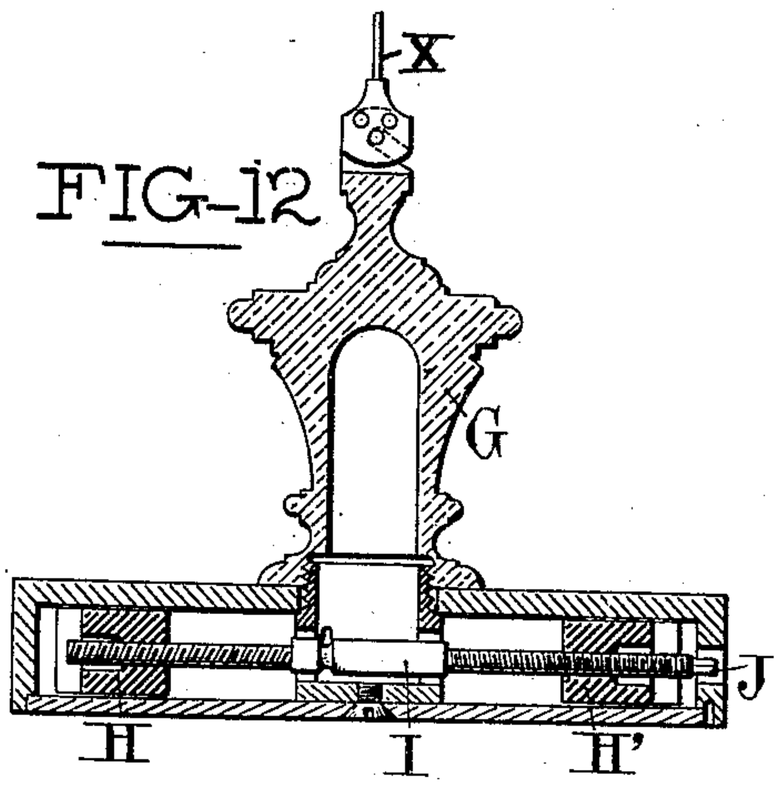


FIG-13

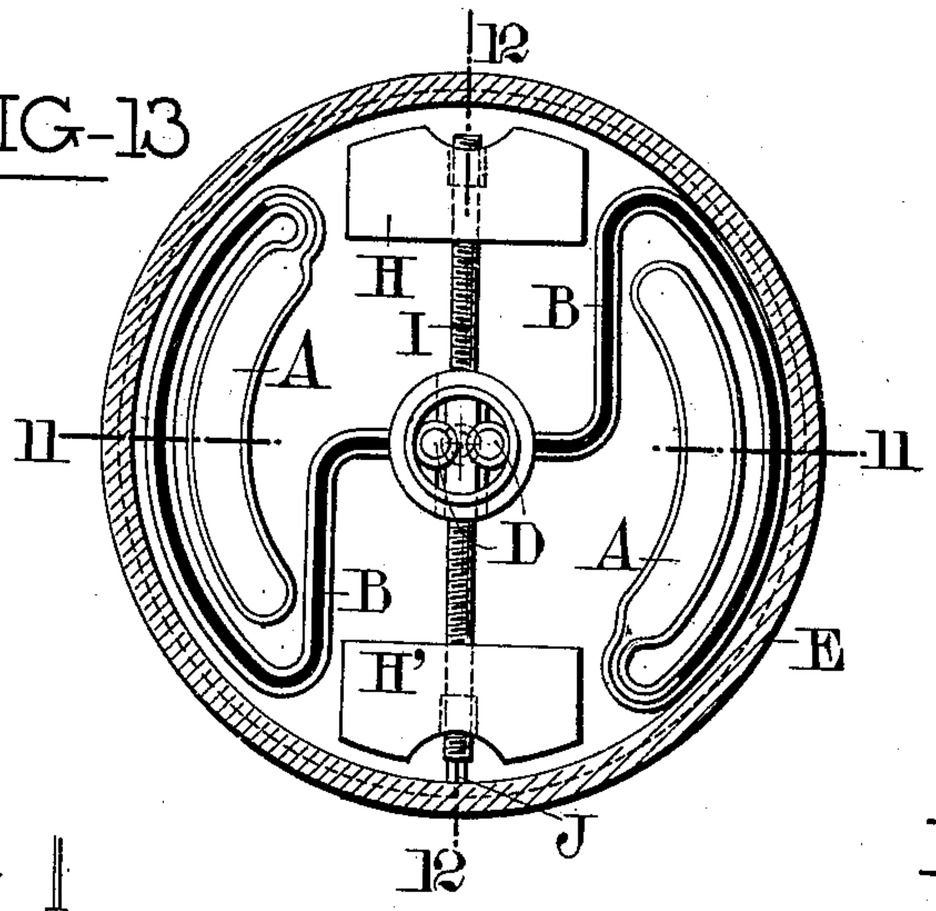


FIG-14

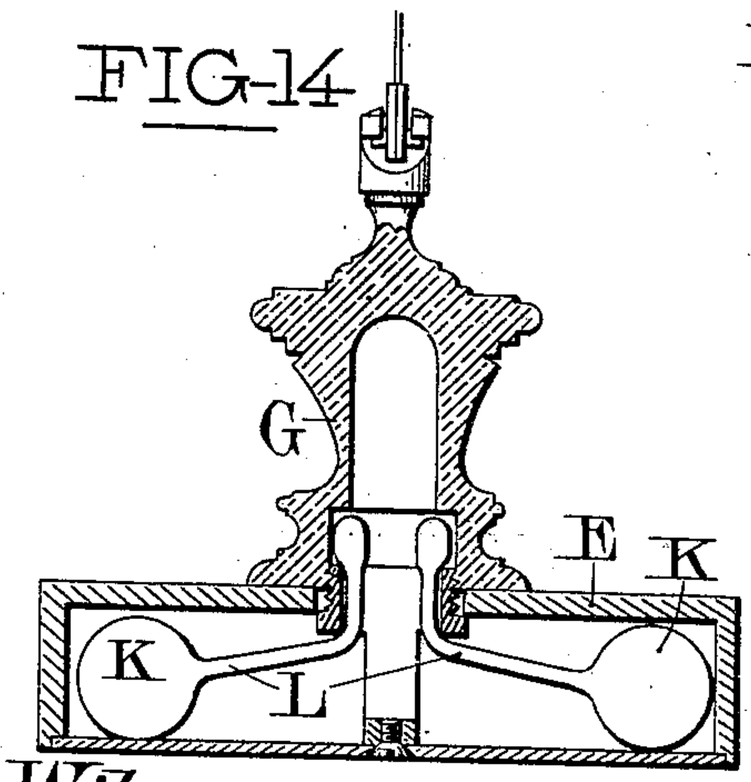
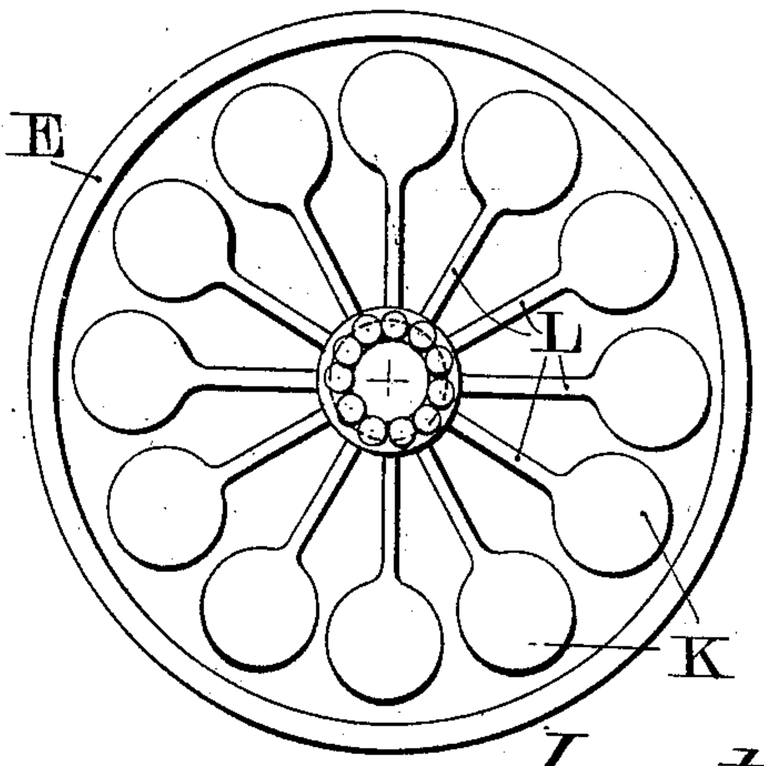


FIG-15



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3 SHEETS—SHEET 3.

FIG-16

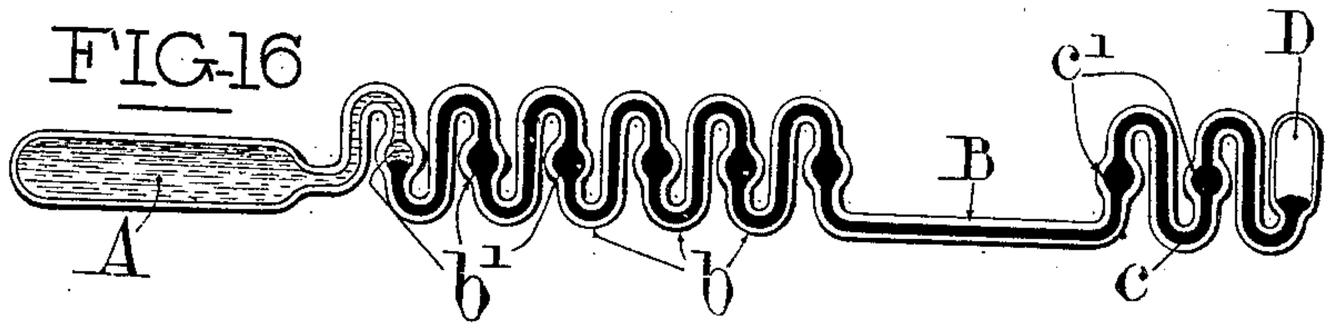


FIG-19

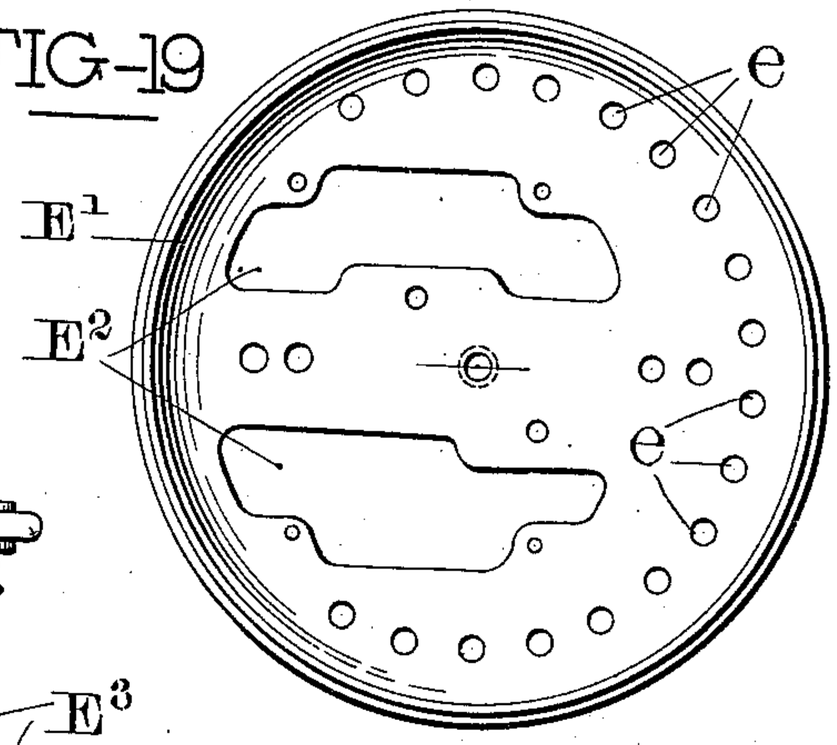


FIG-17

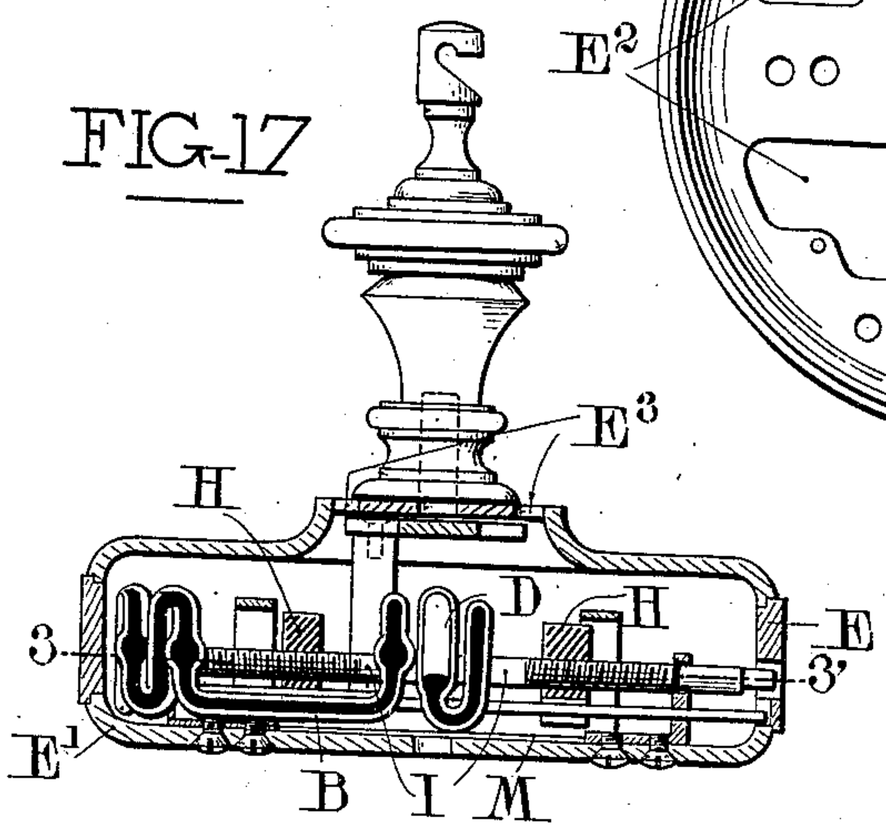


FIG-18

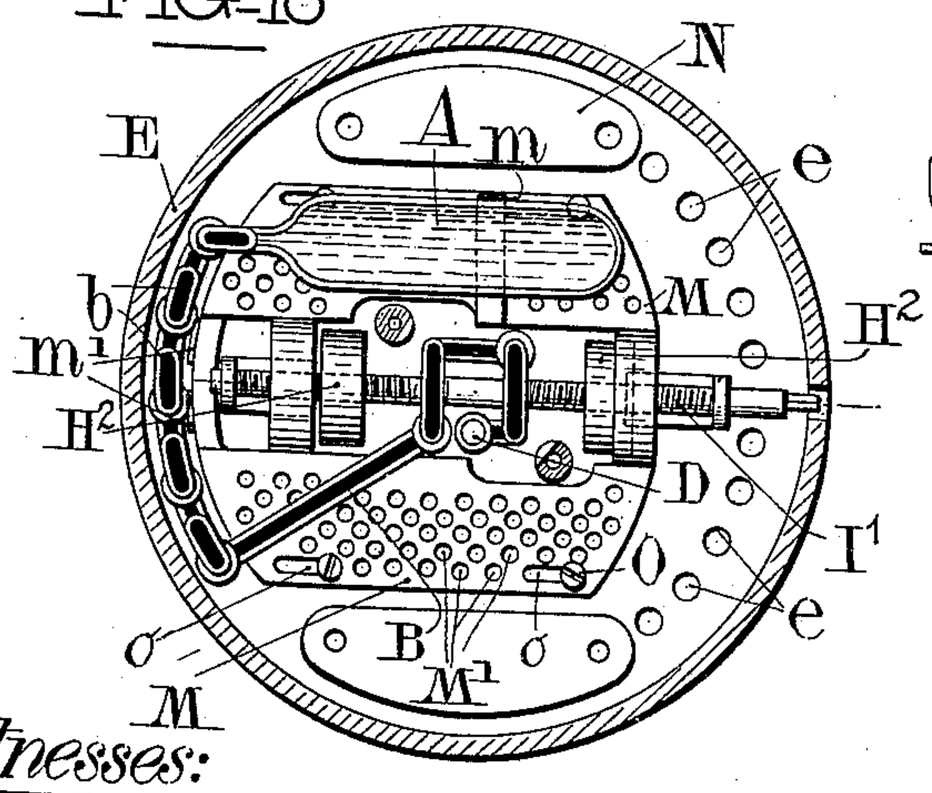
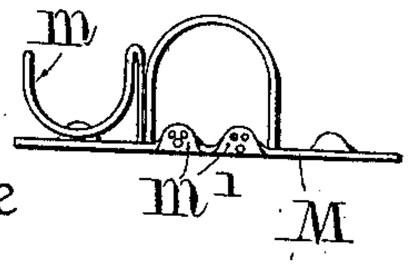


FIG-20



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Inventor:

Claude Grivolas

UNITED STATES PATENT OFFICE.

CLAUDE GRIVOLAS, OF PARIS, FRANCE.

CLOCK-PENDULUM HAVING ALTERNATING ROTARY MOVEMENT.

991,717. Specification of Letters Patent. Patented May 9, 1911.

Application filed February 5, 1910. Serial No. 542,270.

To all whom it may concern:

Be it known that I, CLAUDE GRIVOLAS, a citizen of the French Republic, residing at Paris, in France, have invented certain new and useful Improvements in Clock-Pendulums Having Alternating Rotary Movement, of which the following is a specification.

This invention relates to a regulating or compensating system for clock pendulums having alternating rotary movement.

The inconvenience of long period clocks hitherto constructed and notably those in which the pendulum has a circular alternating movement, consists in the want of regularity of their working. This irregularity is mainly due to variations of temperature which by expansion or modification of the degree of elasticity of the metallic ribbon supporting the pendulum causes a corresponding variation in the length of oscillations of the pendulum.

The present invention is for the purpose of remedying this inconvenience and comprises novel means for obtaining isochronous oscillations within the limits of normal variations of temperature which can occur, by making the weight of the pendulum automatically vary at its periphery. This result is obtained by displacing from the center to the periphery or vice-versa a certain quantity of mercury driven either by its own expansion, or by that of a very expansible liquid such as ether or alcohol in contact with said mercury. An elevation of temperature having the effect of rendering the oscillations slower, corresponds to an automatic displacement of mercury toward the center of the pendulum, with a tendency to acceleration and inversely. These two effects compensating themselves cause the oscillations to always remain isochronous.

The invention will be better understood by referring to the annexed drawings which represent embodiments thereof.

Figure 1 is an elevation of a tube bent at a right angle and provided with two bulbs, one serving as a reservoir for the mercury and one for the expansible liquid. Fig. 2 is a plan view of the tube shown in Fig. 1 bent round and housed in the pendulum casing. Fig. 3 is a sectional elevation on the line 3—3 of Fig. 2. Fig. 4 is a sectional view of a part of the tube showing a modification thereof. Figs. 5, 6 and 7 are plan views and Figs. 8, 9 and 10 respective sectional elevations of other forms of construction of the said tubes. Fig. 11 is a vertical section on the line 11—11 of Fig. 13 showing a pendulum provided with a compensator according to the present invention. Fig. 12 is a vertical section on the line 12—12 of Fig. 13 and Fig. 13 a horizontal section on the line 13—13 of Fig. 11. Fig. 14 is a vertical section and Fig. 15 a plan view of another form of construction of the invention. Fig. 16 is an elevation of a still further form of compensating tube. Fig. 17 is a vertical section of a form of pendulum provided with a tube shown in Fig. 16. Fig. 18 is a horizontal section on line 3^1—3^1 of Fig. 2, the tube being shown in plan view. Fig. 19 is a plan view of the bottom plate of the pendulum, and Fig. 20 an end view of the tube carrying plate.

The regulating or compensating device is constituted by a thermometric tube composed of a bulb A filled with a liquid such as alcohol, ether or other highly expansible substance or mixture rendered viscous and adapted to be mixed with difficulty with the mercury, and a capillary tube B containing a certain quantity of mercury, said tube being bent vertically at one end as at C and surmounted by a bulb D.

The dimensions and quantity of expansible liquid contained in the bulb A are so calculated that each elevation of temperature of one degree centigrade corresponds to the displacement of a determined weight of mercury which will pass from the horizontal tube B into the vertical tube C. By placing said tube in the interior of a pendulum casing E (Figs. 2 and 3) giving to the tube B a curvature permitting it to run along the interior wall of said casing while bending its end in such a manner that the vertical part C occupies the center of the casing, a displacement of a known weight of mercury from the periphery to the center for each degree of increase of temperature may be effected. Similarly at each fall of temperature of one degree there will be a return of the same weight of mercury from the center to the periphery of the pendulum, that is to say, an exact compensation to the effect produced by exterior changes of temperature. It is necessary to place the mercury in the thermometric tube in such a way that reckoning from the lowest point of the limit of temperature chosen it will arrive at the bottom of the vertical part C, and at

the same time it will arrive just at a point sufficiently near the space or bulb A containing the expansible propelling liquid without possibility of its introduction into said space. It is also indispensable to have the reservoir or bulb D at the upper extremity of the vertical part C to contain all the mercury which could be driven back if a sufficiently high temperature is reached for example from 40 to 50 degrees centigrade.

In cases where the coefficient of expansion of the metal employed for the suspension of the pendulum could not be regulated throughout the entire extent of the thermometric scale, it will be possible to exactly compensate the irregularities either by curving the part B of the capillary tube in an irregular fashion (Figs. 5, 6 and 7) in such a manner that at certain temperatures the actual movement of the weight of mercury instead of being made from the extreme periphery to the center will be made from one or more nearer points.

An analogous result could be obtained by bending in a definite fashion the vertical part C of the tube at certain points of its height corresponding to the desired degree of irregularity, so that as in the previous cases the movement of mercury is made from a point more or less removed from the periphery. Figs. 8, 9 and 10 give three examples of this form.

The principles on which the present invention is based being described, no difficulty need be experienced in giving the compensators the shapes and positions most convenient for their application to the pendulums according to requirements.

The compensating devices described may combine a system of small weights H, H^1 placed between them as shown in Figs. 11, 12, and 13 to allow of regulating the movement of the pendulum to a convenient degree of temperature before being sold. The said weights are adapted to be symmetrically displaced by mounting same on a right and left screw-threaded rod I terminating in a head J for reception of an ordinary key introduced from the exterior of the pendulum casing.

The casing E is surmounted by a hollow ornament G in the interior of which the bulbs D and the vertical parts C of the thermometric tubes are housed, and to the upper extremity of said ornament the suspending ribbon X of the pendulum is hooked or otherwise attached.

The employment of two conmpensators in the same pendulum obviates the manipulations required with the employment of a single tube to arrive at an exact compensation, since by combining two compensators having different degrees of expansion, it is possible to rapidly and exactly arrive at the desired result without modifying the volume or properties of the liquid contained in the bulbs A. The symmetry of the system is thus assured and consequently the center of gravity of the pendulum may be maintained in the direction of the suspension ribbon X.

The regulating or compensating devices described above may be modified by the use of mercury alone both for use in compensating and as the expansible liquid.

Figs. 14 and 15 show one form of construction adapted for use in such cases. The compensating devices are formed of a more or less large number of small mercury reservoirs K in the shape of bulbs, placed in the interior of the pendulum casing E, and each terminating in a small tube L directed toward the center of the casing and then rising vertically as in the forms previously described. The contents of each of said tubes expanding under the effect of increase of temperature will cause a flow of mercury toward the center of a quantity which will compensate the effects of expansion produced by the variations of temperature. These said reservoirs K may be of any appropriate shape, occupy any position and be of a variable number according to requirements.

There may be a tendency with the forms described above that during transport of the clock or if the same is disturbed or shaken, and at times even by variations of temperature the continuity of the mercury column becomes broken, and expansible drops of liquid (usually alcohol) or air bubbles are produced between the various divided parts of the mercury column, and owing to capillarity these drops or bubbles constantly tend to travel forward in the tube, till they reach the part of the same passing from the circumference to the center of the pendulum and interfere with the action of the compensator since the mass moved from the periphery to the center of the pendulum has no longer the proper weight.

A form of the device is shown in Figs. 16 to 20 in which the compensating tube is given such shape as to overcome this inconvenience and the use of such modified form of tube leads to the necessity for certain modifications in the construction of the pendulum, which modifications constitute a further feature of the present invention. The tube (Fig. 16) comprises a bulb A containing the expansible liquid, this bulb being connected to the straight part B of the capillary tube by a number of vertically disposed bent portions *b*. The branches of the bent portions *b* in which the expansible liquid travels downward above the mercury are provided with enlargements b^1 having an internal diameter of such size that capillary action is sufficiently counteracted. The tube is similarly formed between the portion B and the bulb D, that is to say with a number of vertically

disposed bent portions c, but the enlargements c^1 are here situated in the branches of the bent portions c wherein the air from bulb D arrives above the mercury. This arrangement prevents the alcohol or other expansible liquid as well as the air from reaching the rectilinear part B of the tube which is always full of mercury.

Experiments have shown that a drop of alcohol from the bulb A and interposed in the column of mercury cannot easily pass one of the enlargements b^1 because at these points two columns of mercury more easily unite and as the alcohol is of less density it remains on the surface of the mercury. When the temperature drops the drop of alcohol is drawn by the contraction of the mercury and returns to the bulb A. If a part of the alcohol passes the first enlargement b^1 it is stopped by the second enlargement and so on, the number of drops which pass becoming gradually less; by providing a sufficient number of bends any introduction of alcohol into the portion B of the tube is prevented without the desired limits of temperature. The same effect is produced in the bends c which prevent the air from reaching the rectilinear part of the tube. By these means the rectilinear part B of the tube which leads from the periphery to the middle of the pendulum contains mercury only and the weight carried from the circumference to the center of the pendulum at each variation of temperature is strictly proportional to this variation. The tube thus formed is curved in the manner shown in plan in Fig. 18 and is arranged on a plate M.

The bulb A rests on a support m while the bends b engage the inner side of the curved wall E of the pendulum casing and are fixed by suitable fastenings to claws m^1; the straight part B of the tube connects these bends to the bends c situated together with the bulb D at the center of the pendulum.

The pendulum is weighted by fixed weights N and by weights H^2 which are movable on a rod I^1 screw-threaded at each extremity, the threads of which are of contrary direction and cause the weights H through which they pass to move toward one another, or apart according to the direction in which the rod is rotated. The position of the plate M carrying the compensating tube is also adjustable, it being secured to the bottom of the pendulum by screws O traversing slots o. Finally perfect equilibrium of the pendulum is obtained by means of weights (not shown) which are fixed by screws traversing the openings e made adjacent the periphery of the base E^1 on the side opposite to the tube.

In order that the tube inclosing the expansible liquid and also the whole tube compensating device may be constantly submitted to the temperature of the surrounding atmosphere, which is an essential condition for the regular action of the pendulum, the bottom E^1 of the pendulum is provided with openings E^2 (Fig. 19), and the plate M is also provided with a number of holes m^1 to allow the air to easily pass to the interior of the pendulum. Openings E^3 are also made in the cover of the pendulum so as to provide for a continuous air circulation. Any variation of temperature can thus be immediately compensated for.

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

1. A compensating device for clock pendulums, having alternating rotary movement comprising a closed conduit having a series of substantially rectangular bends intermediate its ends, and an expansible liquid in said conduit adapted to be displaced therein under variations of temperature.

2. A compensating device for clock pendulums, having alternating rotary movement comprising a closed conduit having a series of substantially rectangular bends intermediate its ends, and one end bent rectangularly to the axis of said conduit, and an expansible liquid therein adapted to be displaced in said conduit under variations of temperature.

3. A compensating device for clock pendulums, having alternating rotary movement comprising a closed conduit having a series of substantially rectangular bends having bulbous enlargements intermediate its ends and one end bent rectangularly to the axis of said conduit, bulbous enlargements at the extremities of said conduit, mercury disposed in one portion of said conduit, and an expansible liquid disposed in another portion thereof, said mercury and liquid being in contact and adapted for displacement in said conduit under variations of temperature.

4. The combination with a pendulum adapted to have alternating rotary movement, of a compensating device therefor comprising a closed conduit having a plurality of substantially rectangular bends intermediate its ends and disposed adjacent the periphery of the pendulum, mercury disposed in one portion of said conduit, and an expansible liquid disposed in another portion, said mercury and liquid being in contact and adapted for displacement in said conduit under variations of temperature, whereby the weight of the pendulum is caused to vary at its periphery.

5. The combination with a pendulum adapted to have alternating rotary movement, of a compensating device therefor comprising a closed conduit having a plurality of substantially rectangular bends provided with bulbous enlargements intermediate its ends, and a bulbous enlargement

at each end, said conduit being disposed for the major part adjacent the periphery of said pendulum and having one of its ends bent rectangularly to its axis and disposed at the center of oscillation of the pendulum, mercury contained in one portion of said conduit, and an expansible liquid contained in another portion thereof in contact with the mercury, and adapted to be displaced in the conduit under variations of temperature, whereby the weight of the pendulum is caused to vary at its periphery.

6. The combination with a pendulum adapted to have alternating rotary movement, of a compensating device therefor comprising a closed conduit having a plurality of substantially rectangular bends intermediate its ends and disposed adjacent the periphery of the pendulum, mercury disposed in one portion of said conduit, an expansible liquid disposed in another portion, said mercury and liquid being in contact and adapted for displacement in said conduit under variations of temperature, and adjustable weights adapted for movement toward and from said periphery, whereby the weight of the pendulum at said periphery is caused to vary.

7. The combination with a pendulum adapted to have alternating oscillating movement, of a casing, a compensating device disposed within said casing comprising a closed conduit disposed for the major part adjacent the periphery of said casing, an expansible liquid contained within said conduit and adapted for displacement therein under variations of temperature, whereby the weight of the casing is caused to vary at its periphery, and said casing having apertures whereby the surrounding atmosphere may have access to the compensating device.

In witness whereof I have signed this specification in the presence of two witnesses.

CLAUDE GRIVOLAS.

Witnesses:
DEAN B. MASON,
LÉON GRIVOLAS.