Aug. 24, 1943. F. G. BOUCHER 2,327,697

GRAVITY METER

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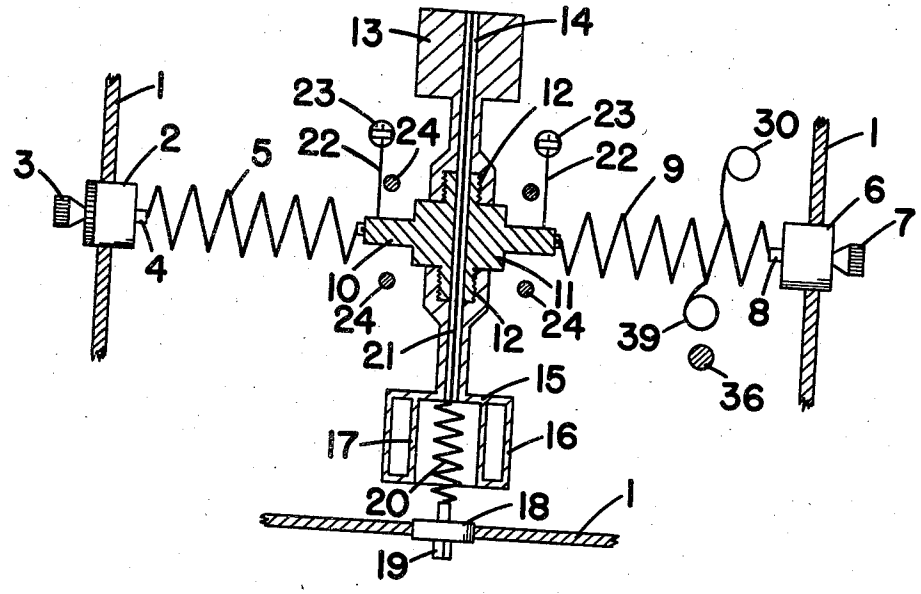

FIG. 1

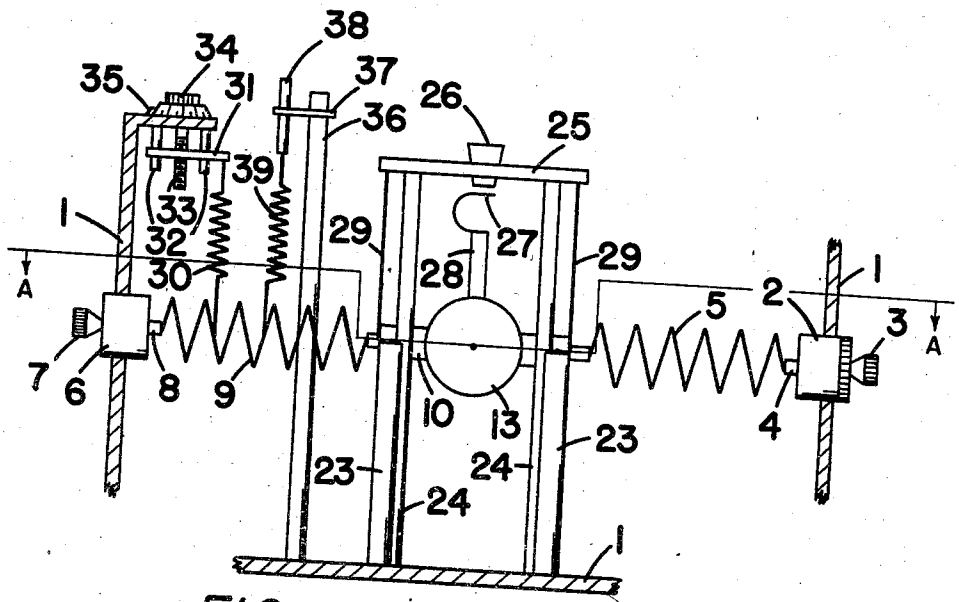

FIG. 2

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GRAVITY METER

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3 Claims. (Cl. 265—1.4)

The present invention is directed to a gravity meter.

The principal object of the present invention is the provision of a device of the character described in which a weight subject to the attraction of gravity is suspended as nearly freely as possible, whereby it is extremely sensitive to variations of gravity.

An additional object of the present invention is the provision in a device of the character described of a barometric compensator the function of which is to eliminate any error in the gravity readings due to the buoyancy of the gravity responsive mass.

A further object of the present invention is the provision in a device of the character described of a gravity responsive mass suspended between torsional springs and a reading device connected directly to a turn of one of the torsional springs for exerting the force necessary to restore the mass to its null position.

Further objects and advantages of the present invention will appear from the following detailed description of the accompanying drawing in which

Fig. 1 is a top view of the moving system, partly in section, along the line A—A of Fig. 2, and

Fig. 2 is a rear elevation of Fig. 1.

Referring to the drawing in detail, numeral 1 designates the walls of the case in which the moving system is arranged. A torsional head 2 is arranged in one side wall of the casing and has a rotatable screw 3 projecting outside the casing for turning the stem 4 to which is attached one end of a torsional spring 5. A second torsional head 6 is arranged in the opposite side wall of the casing in line with the torsional head 2 and is also provided with an adjusting screw 7 protruding outside the casing for turning the stem 8 to the free end of which is attached one end of a second torsional spring 9 extending toward torsional spring 5.

The inner ends of springs 5 and 9 are connected to opposite ends of a cross piece 10, the central portion of which is in the form of a barrel 11 having extending from each side thereof a threaded boss 12. Screwed on to one of these bosses is a mass 13 which has a centrally located passage 14. This passage extends through the barrel 11 and also through a barometric compensator 15 connected to the other boss. The compensator is in the form of an annular chamber formed by an outer shell 16 and an inner shell 17 having their ends connected together. The volume of this annular space is the same as the volume of the mass 13 so that each displaces the same amount of air. This compensator weighs less than the mass 13. It may also be noted that both are located the same distance away from the center of the cross piece 10.

A stud 18 is fixed in the side wall of the casing at a point opposite the end of the compensator 15, and has an adjustable head 19 extending outside the casing. A spring 20 has one of its ends fixed to the stud and the other to a filament 21 which passes through the passage 14 and is fixed to the outer end of the mass 13. The spring constantly urges the movable system toward the side wall to which the stud is attached. Opposing the action of the spring are fibers 22, one of which is secured to each side of the cross member 10 and is anchored on a suitable post 23.

Symmetrically arranged around the cross piece 10 are four upright posts 24 which carry at their upper ends a frame work 25 which, in turn, carries the reading device consisting essentially of a microscope 26 which has a scale across the eyepiece over which moves a pointer 27 which is a very fine curved fiber carried by a post 28 mounted on the center of the cross member 10. Fibers 29 are provided for suspending the moving system vertically, each fiber having one end connected to the frame work 25 and its other end connected to the cross piece 10. It may be noted here that fibers 29 as well as fibers 22 are so arranged as to intersect the horizontal axis of rotation of cross piece 10.

In the foregoing, the moving system of the gravity meter of the present invention has been described. It will be seen that it is so mounted as to be extremely unstable and therefore especially sensitive to very slight variations in gravity. With the system shown it is possible to measure changes in gravity as small as $^5/_{100}$ of a milligal. The instability which renders this system so sensitive is effected, for the most part, by the period spring 20 exerting a force through the axis or center of the moving system, but on the opposite side of the center from the point where the spring is attached. For this reason, any slight movement of the mass due to changes in gravity is immediately amplified, since, once the system is off dead center, the force of the spring tends to pull it farther away from the dead center. In this connection, it is to be noted that the tension of the spring 30 must be regulated so as to limit the extent to which it will pull the system off dead center.

There is also provided in the system means for restoring it to its null position after it has re-

acted to a change in gravity. This consists of a spring 30 having one of its ends secured to a movable block 31 which slides on studs 32 and is actuated by a micrometer screw 33, the latter extending above the top of the casing and being provided with a graduated head 34. Arranged on the casing is a fixed pointer 35 to permit the reading of the head 34. The other end of the spring is secured to a turn of the torsion spring 9 near the fixed end of the spring. It is shown attached to the second turn from the fixed end, but can also be attached to the first turn. The point is that, the closer this spring is attached to the fixed end of the torsion spring, the greater the force which must be exerted by the spring 30 to restore the system to null position, and therefore the greater number of turns of the head 34 is required. Thus, for a small variation in gravity a large movement of the head 34 is required to restore the system to its null point, and this results in increased sensitivity.

Because the readings might be affected by a small change in temperature, there is also provided in the system a temperature compensator. This consists of an upright post 36 to the top of which is attached a laterally extending arm 37, through the free end of which is fixed a vertically arranged rod 38, to the lower end of which is connected one end of a spring 39, the other end of which is attached to a turn of the torsion spring 9.

In one system the post 36 is made of aluminum and the rod 38 is made of Invar which is insensitive to temperature changes. The aluminum post 36 will tend to expand with increase in temperature, and the torsion spring 9 will also tend to expand. But the expansion of the aluminum post will increase the tension on spring 39 which, in turn, will exert a force on spring 9 restraining it from expanding or compensating for its expansion. It may be noted here that, if desired, the post 36 can be of Invar and the rod 38 of aluminum, if the reverse effect is desired. If the spring 9 is one which tends to wind up upon expansion, and the spring 39 is so connected that an upward pull thereon would resist the winding of the spring 9, the temperature compensating system is one which will exert such an upward pull with an increase in temperature. On the other hand, if the spring 39 is so connected to spring 9 that a downward thrust by this spring would be necessary to oppose the winding of the spring 9, the temperature compensating system is one which will exert such a downward thrust upon an increase in temperature. Likewise, if spring 9 is one which tends to unwind with an increase in temperature, then the temperature compensating system will be one which exerts either an upward pull or a downward thrust on spring 39, depending on the side of the spring 9 to which spring 39 is connected. If desired, both post 36 and rod 38 can be of Invar, and arm 37 can be of bimetallic strip which bends upwardly at its outer end with an increase in temperature.

It will be apparent that many changes in details can be made without departing from the scope of the present invention. It may be mentioned that in practice clamps are provided for molding the system rigid when it is not in use so as to avoid damage due to travel over rough terrain. Any type of clamping means can be utilized and since this particular feature forms no part of the present invention, no clamping means is shown for the sake of clarity.

The nature and objects of the present invention having been thus described and illustrated, what is claimed as new and useful and is desired to be secured by Letters Patent is:

1. A gravity meter, comprising a moving system including a horizontally arranged body having a mass extending horizontally from one side thereof, torsional means normally holding said mass and said body in a horizontal position, means for applying a force to said mass through the center of gravity of said body, and means for resisting the effect of said force on said body arranged in the same horizontal plane as the force applying means.

2. A gravity meter, comprising a moving system suspended by torsional means, said system including a center piece, hollow arms of equal length extending laterally in opposite directions from said center piece, a mass carried by the end of one of said arms, a body carried at the end of the other of said arms having less weight than the mass but capable of displacing the same volume of air, means for applying a force to said mass along the axis of said arms from a point on the side of said center piece opposite said mass, and means arranged in the same horizontal plane as said last means for resisting the effect of said last means on said system.

3. A meter according to claim 2 in which the force applying means is a filament connected to said mass and extending through said hollow arms through a tension spring to a support, and the force resisting means is a pair of filaments connected to said center piece and to fixed supports.

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