guide rails **38**, **40**. The cam **30** is of unitary construction and may be fabricated using a numerical control milling machine. Cam surface **80** controls the movement of the carriage **14** and causes free fall of the measuring mass **12**. Cam surface **82**, which is displaced from cam surface **80** by 180 degrees, controls the compensating vertical movement of compensating mass **60**. The portion of the cam defined by cam surface **82** is weighted to provide a compensating mass to cancel the weight differential created by the free fall of the measuring mass **12**. It can be appreciated by those skilled in the art that the weight differential created when the mass **12** is in free fall would cause a very slight recoil or displacement of the entire assembly which would have a deleterious effect on the accuracy of the measurement. Thus, it is desirable to provide a compensating mass to eliminate any free-fall caused weight change. In the present invention, both mass displacement and vibration are effectively eliminated by the combination of compensating cam **82** and compensating mass **60**.

The radii of the cam surface **80** may be characterized by the following equations:

$k=0.08-0.034014167-(0.0217690670.03/0.032)$

$y=0.021769067(20/80)^2$

where k and y are constants which are a function of g.

$r1[\phi]:=0.0.08-0.002-0.021769067(\phi/80)^2$ where r1 is the cam radius at the controlled lift off region, from 20 to 80 degrees of rotation as indicated in FIG. **3**, and ϕ is the angle of rotation. It should be noted that c**1** is the actual circumference of the cam **30** at the lift off region and c**2** is the grave-curve or the actual path of the center of mass of the measuring mass **12**.

$r2[\phi]:=k+(0.0217690670.03/0.032)((\phi-180/60)^2$, for ϕ=100–160 degrees. This is the soft catch portion of the cam **30** rotation where the measuring mass **12** gradually catches up to the carriage **14**. At 160 degrees, free fall of the measuring mass **12** is ended as the mass **12** will rest on the carriage **14**.

$r3[\phi]:=k+(0.08-k)0.5((\phi-160)/180)^2$, for ϕ=160 to 260 degrees, and

$r4[\phi]:=0.08-(0.08-k)0.5((360-\phi)/100)^2$, for ϕ=260 to 360 degrees.

r5, which characterizes the grave-curve, may be expressed as follows:

$r5[\phi]:=0.08-0.021769067(\phi/80)^2$.

$r011[\phi]$ and $r021[\phi]$ are the radii of the cam for ϕ from 0 to 10 degrees, and 10 to 20 degrees, respectively. These are the radii of the cam **30** during acceleration of the carriage **14** to the liftoff velocity and may be expressed as follows:

$r011[\phi]:=0.08-0.001(\phi/10)^2-0.021769067(\phi/80)^2$;

$r021[\phi]:=0.08-0.021769067(\phi/80)^2-0.002+0.001((20-\phi)/10)^2$.

Finally we have,

$r102[\phi]:=0.08-0.002-0.021769067(\phi/80)^2+0.001((80-\phi)/10)^2$; for ϕ=80–90 degrees;

$r103[\phi]=0.08-0.021769067(\phi/80)^2-0.001((100-\phi)/10)^2$; for ϕ=90–100 degrees.

It can be readily appreciated that the above described radii are measured from the axis of rotation of the cam **30**.

In order to reduce the overall size and weight of the gravimeter containing the mechanism of the invention, the cam **30** size is chosen to have a diameter of approximately 15 cm, which is dictated by the length of free fall and allowable (about 2.5 g) deceleration together with a return to start motion which purposely never exceeds 1 g, where g is the known local acceleration due to gravity. With this cam **30** size, the length of free fall is about 2 cm. The rotation rate of about 0.3 seconds per rotation allows for three measurements per second which is relatively fast compared to conventional gravimeters. It should be noted that the free fall time, the deceleration time, and the return to start time must equal the cam's rotational period.

The motor speed required depends on what the local g is, which is known. Thus a fine adjustment of motor speed is required, and to that end, a suitable adjustment means, i.e., a potentiometer, is required. The adjustment is required to ensure that a cam **30** shape calculated in accordance with the above equations creates an appropriate lift off and causes the support carriage to fall appropriate to the local value of g.

In operation, the shaft **32** and cam **30** are rotated at the 0.3 seconds per rotation rate, causing the measuring mass **12** to separate from the carriage **14** once per rotation. When the measuring mass **12** is in free fall, measurements of its rate of descent can be made by the interferometer apparatus. As the carriage **14** is moving down, compensating mass **60** travels upward thus canceling any disturbance caused by the weight displacement of the carriage **14**. Likewise, as the measuring mass **12** is in free fall, cam **30**, which is balanced so that the portion of the cam **30** defined by cam surface **82** is moving upwards and is displacing a weight equivalent to the weight of the measuring mass **12**.

Free fall commences after the carriage **14** (has experienced an initial acceleration of about 2.5 g, the acceleration being caused by the shape of the cam surface **80** just prior to the lift off region as shown in FIG. **3**.

It is to be understood that the provided illustrative examples are by no means exhaustive of the many possible uses for this invention.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

It is to be understood that the present invention is not limited to the sole embodiment described above, but encompasses any and all embodiments within the scope of the following claims:

I claim:

1. A gravimeter mechanism contained within a dropping chamber for periodically causing the free fall of an object, said mechanism comprising:

a support frame including a base;

a carriage having a horizontal surface upon which said object may be supported, said carriage supported for reciprocating vertical movement by said support frame;

a cam member, said cam member rotatably supported by a drive shaft supported by said support frame, said cam member having first and second cam surfaces, the cam surfaces defining two mass balanced portions of said cam member, the first one of said cam surfaces operably connected to said carriage for causing alternating vertical movement of said carriage in response to rotation of said drive shaft.

2. The mechanism of claim **1** wherein said first cam surface has varying radii, the variation in the radii of said first cam surface is chosen to effect an initial downward acceleration of said carriage sufficient to cause said object to be in free fall during downward travel of said carriage.

3. The mechanism of claim **2** wherein said downward travel of said carriage in response to rotation of said cam member is further characterized by a controlled deceleration period following the acceleration, said controlled deceleration period effecting a soft catch of said object.

4. The mechanism of claim **1** wherein said support frame includes an opposing pair of guide rails secured to said base, said carriage having a pair of cylindrical bearing members extending therefrom and slidably secured about respective ones of said guide rails.