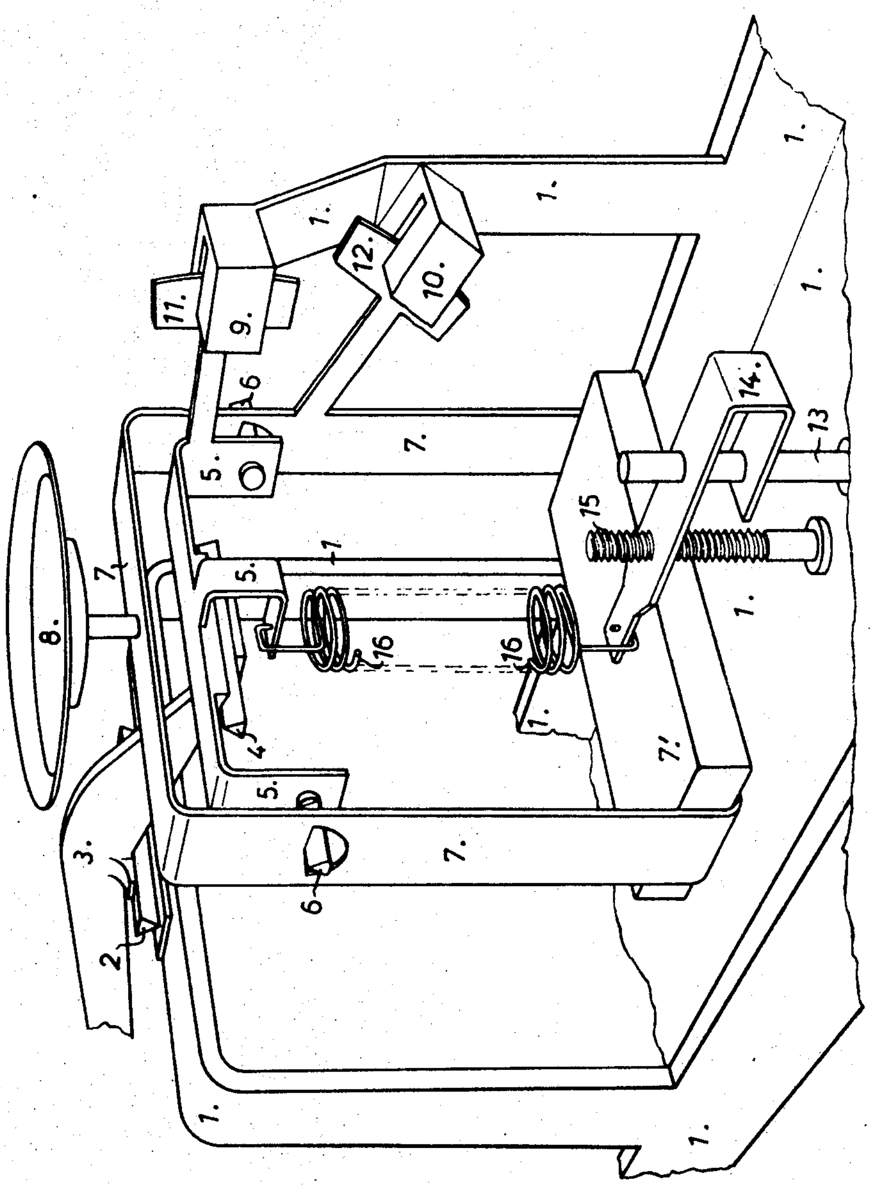
Oct. 14, 1969 J. MEIER 3,472,327

PRECISION BALANCE WITH DUAL MAGNETIC DAMPING

Filed Nov. 9, 1967



INVENTOR:

Johann Meier

BY:

Lawrence E. Laubscher

ATTORNEY

United States Patent Office

3,472,327
Patented Oct. 14, 1969

1

3,472,327
PRECISION BALANCE WITH DUAL MAGNETIC DAMPING

Johann Meier, Stafa, Switzerland, assignor to Mettler Instrumente AG, Zurich, Switzerland, a corporation of Switzerland

Filed Nov. 9, 1967, Ser. No. 681,823
Claims priority, application Switzerland, May 9, 1967, 6,560/67
Int. Cl. G01g *23/10*
U.S. Cl. 177—185 4 Claims

ABSTRACT OF THE DISCLOSURE

Precision balance comprising a balance beam fulcrumed on the balance frame, a pendulum suspended from an outer knife edge of the balance beam, and a pan carrier linked to the pendulum, said pan carrier supporting a scale pan at its top end and having a counterweight at its bottom end. Means comprising a plurality of electromagnetic eddy current brakes are provided which enable the vibrations of the pendulum and of the pan carrier to be suppressed independently of one another and each in relation to the frame of the balance.

In precision balances of conventional construction a downwardly extending intermediate carrier is suspended from the outer knife edge of the beam. The pan carrier, having the scale pan at its lower end, is in turn linked to the intermediate carrier. The axis of rotation of the joint between the pan carrier and the intermediate carrier is parallel to and located in the space below the outer knife edge of the beam. The intermediate carrier may also be provided with supports to receive control weights. If the balance has spring taring means, one end of one or more helical springs will preferably engage the beam itself. In order to suppress vibrations of the pan carrier a friction pin is finally provided, which is moved from the frame of the balance and can be pressed resiliently against the underside of the scale pan.

For precision balances where a less high degree of accuracy and sensitivity is required it is usually preferable to have a construction in which the scale pan is mounted at the top end of the pan carrier and in the space above the outer knife edge of the beam. The pan carrier is then guided by means of an additional steering lever. Any control weights are deposited on supports on the pan carrier itself. Where a spring taring device is used it is preferably a tension spring which acts on the pan carrier in an at least approximately vertical direction and pull it upwards or downwards as required. As the pan carrier is guided parallel it cannot swing like a pendulum, so means for suppressing such swinging are unnecessary. On the other hand it is custom to provide an electromagnetic eddy current brake acting between the beam and the frame for aperiodic movement of the balance.

Precision balances have finally been proposed, wherein a pendulum having a counterweight at its lower end is suspended from the outer knife edge of the beam. At the top of the pendulum and in the space above the outer knife edge a pan carrier is supported by means of an universal joint. The scale pan is located above this joint at the top of the pan carrier. A further counterweight is again attached to the bottom end of the pan carrier and extends sufficiently far below the universal joint and below the counterweight provided on the pendulum. If control weights are provided these are deposited on supports mounted on the pendulum. According to the frequently asymmetric loading of the scale pan definite pendulating movements of the pan carrier occur and are finally transmitted to the pendulum itself. Where spring taring means acting on the pan carrier or on the pendulum are used this pendulating tendency is still further increased. In order to eliminate this undesirable swinging, a first friction pin permanently acting between the pendulum and the pan carrier and a second friction pin acting between the frame of the balance and the pan carrier have been provided, the latter being actuated only as required by means of a special operating member. However, a certain amount of practice and attentiveness is required to handle this member correctly if the pendulum swing is to be suppressed rapidly enough. It is for reasons such as these that precision balances of the last mentioned construction are often regarded as impracticable or inconvenient.

According to the present invention there is provided a precision balance comprising a beam which is fulcrumed on the frame of the balance by means of a centre knife edge and which has an outer knife edge from which a pendulum is suspended, a pan carrier linked to the pendulum for movement about an axis of rotation parallel to said knife edges of the beam and carrying a scale pan at its top end, a counterweight mounted at the bottom end of the pan carrier, and a plurality of electromagnetic eddy current brakes which enable the pendulating movements of the pendulum and of the pan carrier to be suppressed independently of one another and each in relation to the frame of the balance. Preferably the eddy current brakes comprise permanent magnets fixed in the frame of the balance and metal vanes mounted on the pan carrier and on the pendulum, the vanes entering the magnetic fields of the associated permanent magnets. It is advantageous for the axis of rotation of the pan carrier relative to the pendulum to be below the outer knife edge of the beam. And finally, if a taring device is provided in the balance frame, it is preferable for a taring spring or taring springs to act on a part of the pendulum located below the outer knife edge of the beam, exerting tension in an at least approximately vertically downward direction.

These and other objects and the advantages of the invention will become apparent from the study of the following specification when read in connection with the accompanying drawing, in which the single figure is a perspective view of the essential parts of a precision balance according to the present invention and in which any details not directly essential to an understanding of the invention have been omitted.

Referring to the drawing, the centre knife edge **2** of the beam **3** is fulcrumed on the frame **1** of the balance. Only one arm of the beam **3** is illustrated which usually is the shorter one. The longer arm provided with a counterweight and a scale is shown only fragmentarily in the drawing. The outer knife edge **4**, extending parallel to the centre knife edge **2**, is mounted on the shorter arm of the beam. A yoke-shaped pendulum **5**, extending below the outer knife edge **4**, is seated on the latter again for pivotal movement. The pendulum **5** is provided with two co-axially mounted knives **6**, the common axis of the knives being parallel to that of the knives **2** and **4** and being located in the space below the outer knife **4**.

The pan carrier **7** is pivotally suspended from the knives **6** of the pendulum **5** and carries the scale pan **8**, which is located in the space above the outer knife **4** and thus bears on the top end of the pan carrier **7**. At the bottom end of the latter and sufficiently far below the knives **4** and **6** there is mounted a counterweight **7'**. This construction makes it unnecessary for a separate counterweight to be provided on the pendulum **5**. The position of stable equilibrium of the pendulum **5** is provided purely by the total weight of the pan carrier **7** suspended from, including its counterweight **7'**. Hence when there is an eccentric load on the scale pan **8** only the pan carrier **7** will pivot accordingly about the knives **6**, while the pendulum

5—once all the pendulating movements have died away—will remain in its original position on the outer knife edge 4. However, the pendulating movements of the pan carrier 7 about the knives 6 and of the pendulum 5 about the outer knife 4 are obviously mechanically coupled to one another, and such coupled pendulating movements can be rapidly extinguished only if each is powerfully damped independently of the other. Moreover the damping force must be progressive, in the sense that it increases with the amplitude of the pendulating movement. These requirements can be met with the aid of electromagnetic eddy current brakes.

In the example illustrated in the drawing two U-shaped permanent magnets **9** and **10** are provided, each magnet being rigidly attached to the frame **1** of the balance. Pendulating movements of the pendulum **5** are suppressed by means of the copper of aluminium vane **11** attached thereto, which enters the magnetic field of the magnet **9**. The pan carrier **7** is similarly provided with a copper or aluminium vane **12** which can move between the poles of the other magnet **10** without contacting the same. The two magnets **9** and **10** not only suppress the pendulating movements of the pendulum **5** and of the pan carrier **7** but also contribute to effect an aperiodic pivoting movement of the balance beam **3**. It may even be possible to dispense with the usual damping means acting between the balance beam **3** and the balance frame **1**.

The above mentioned electromagnetic eddy current brakes do not require any additional operating member and this results in an automatic suppression of any pendulating movements which may occur. The damping action obtainable can be made so strong that spring taring means can readily be fitted as illustrated in the drawing. These are also merely indicated in a diagrammatic way and comprise the guiding bar **13** which is rigidly fixed in the frame **1** and along which the stretching member **14**, mounted thereon, is adapted to move. Such movement is effected by means of a threaded spindle **15** rotatably mounted in the frame **1** of the balance. The taring spring **16** is stretched between the member **14** and a point on the pendulum **5** below the centre knife **4**, so that it exerts a downward tensile force on the pendulum **5** at least approximately in a vertical direction. Instead of the one spring **16** a plurality of taring springs may be used, acting in parallel or in series.

Finally, if the balance is to be provided with control weights, the supports to receive them should be mounted as usual on the pendulum **5** and preferably in the space below the knives **6**.

While in accordance with the provisions of the Patent Statutes, the preferred form and embodiments of the invention have been illustrated and described, it will be apparent to those skilled in the art that modifications may be made without deviating from the invention.

What is claimed is:

1. A precision balance comprising a beam which is fulcrumed on the frame of the balance by means of a centre knife and which has an outer knife from which a pendulum is suspended, a pan carrier linked to said pendulum for movement about an axis of rotation parallel to said knives of the balance beam and carrying a scale pan at its top end, a counterweight mounted at the bottom end of said pan carrier, and a plurality of electromagnetic eddy current brakes which enable the pendulating movements of said pendulum and of said pan carrier to be suppressed independently of one another and each in relation to the frame of the balance.

2. The invention as defined in claim **1** wherein said eddy current brakes comprise two permanent magnets fixed in the balance frame and two metal vanes fixed respectively to said pendulum and to said pan carrier, said vanes entering the magnetic fields of the two permanent magnets respectively.

3. The invention as defined in claim **1** wherein the axis of rotation of said pan carrier relative to said pendulum is below the outer knife of said balance beam.

4. The invention as defined in claim **1** wherein one or more taring springs of a taring means mounted in the balance frame act on part of said pendulum located below the said outer knife of the beam, the tension due to said taring springs being exerted in an at least approximately vertical downward direction.

References Cited

UNITED STATES PATENTS

1,900,641	3/1933	Gattoni	177—185
1,937,223	11/1933	Gattoni	177—185
3,403,741	10/1968	Sauter	177—263 X

RICHARD B. WILKINSON, Primary Examiner

G. H. MILLER, Jr., Assistant Examiner