

Jan. 8, 1952

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2,581,807

ANALYTICAL BALANCE

Filed Sept. 21, 1950

4 Sheets-Sheet 1

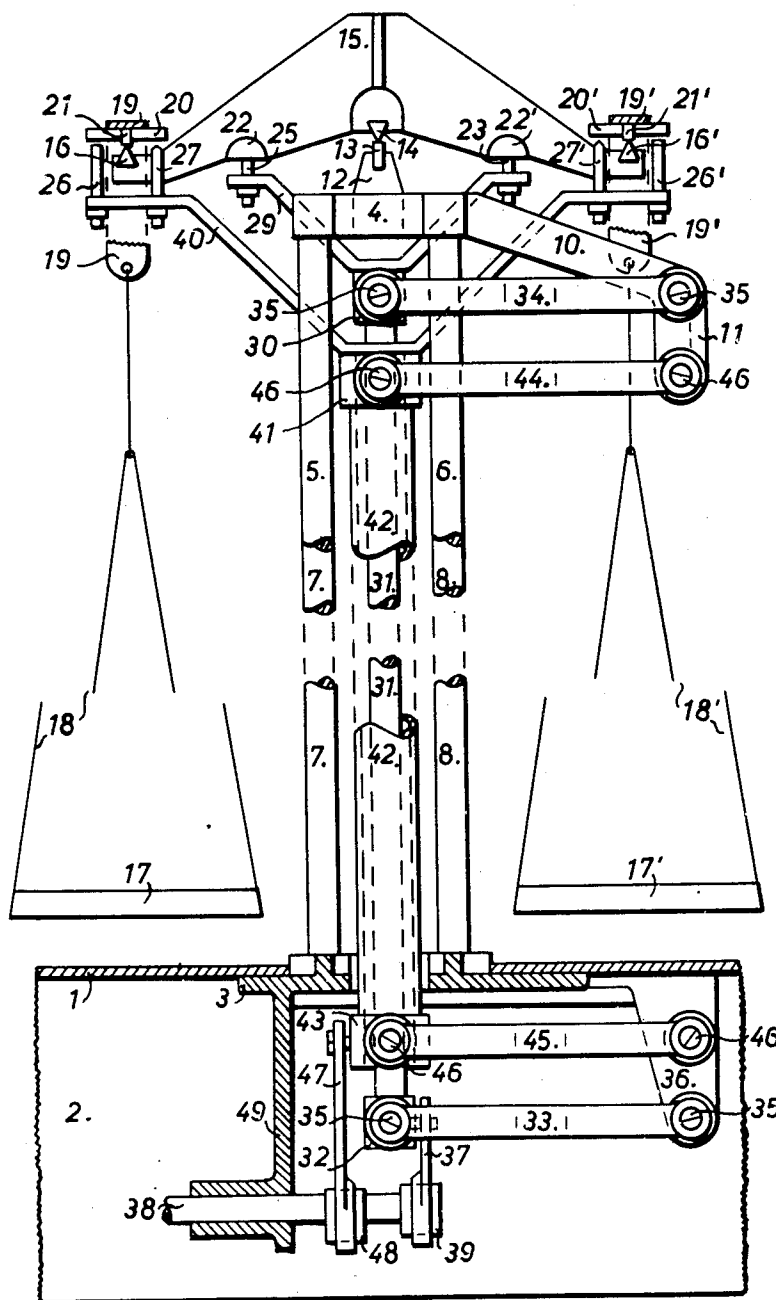


Fig. 1.

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Fig. 2.

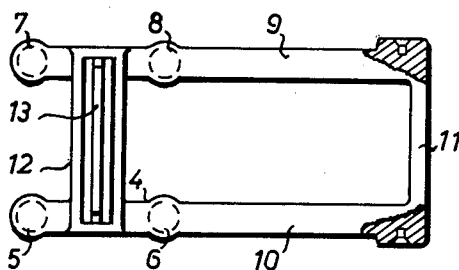


Fig. 3.

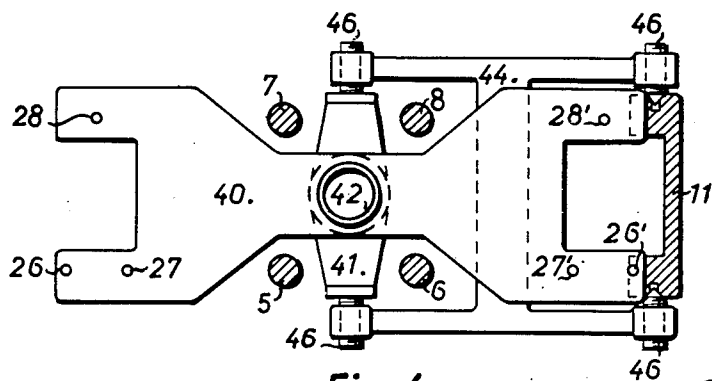
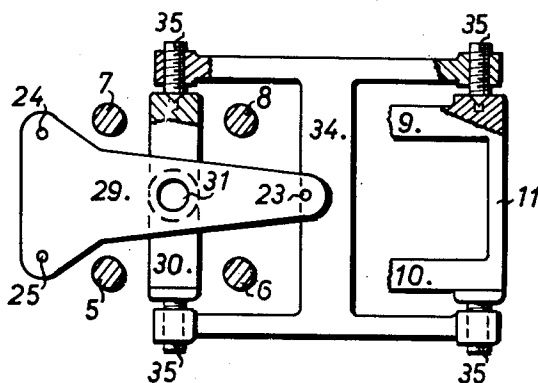


Fig. 4.

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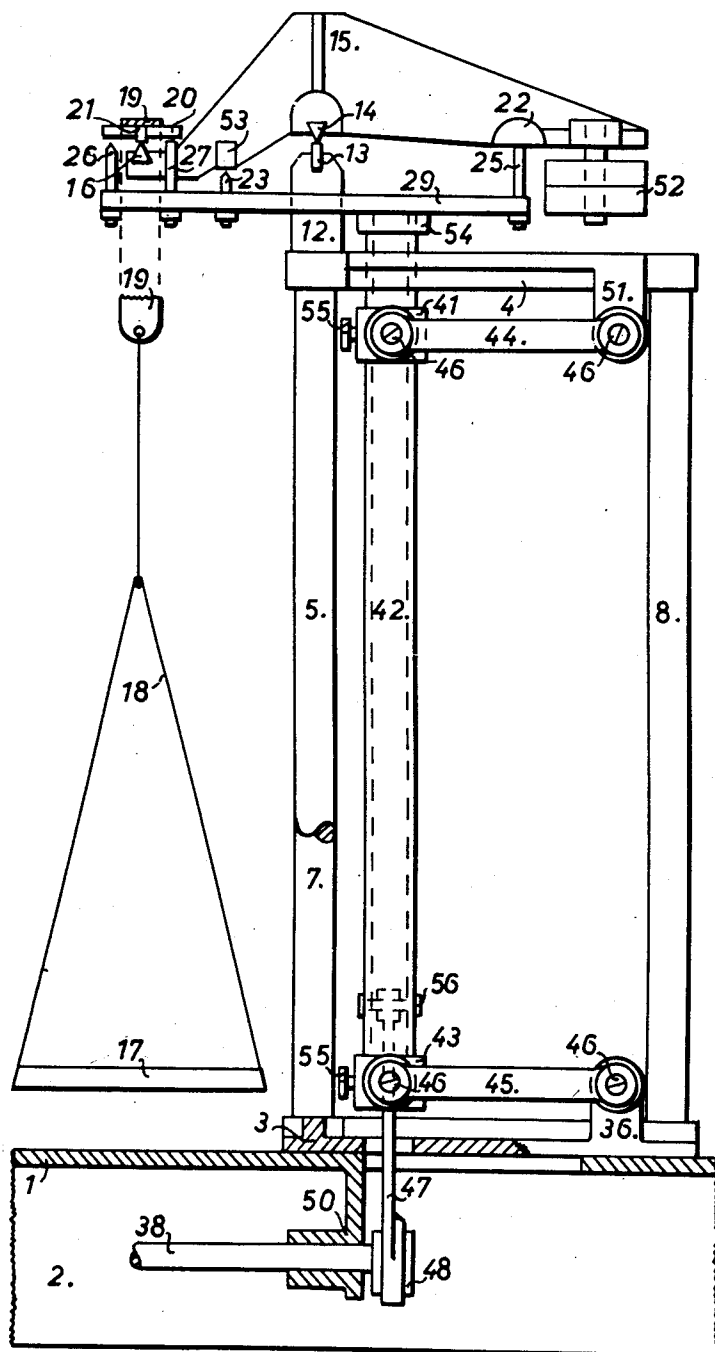


Fig. 5.

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Fig. 6.

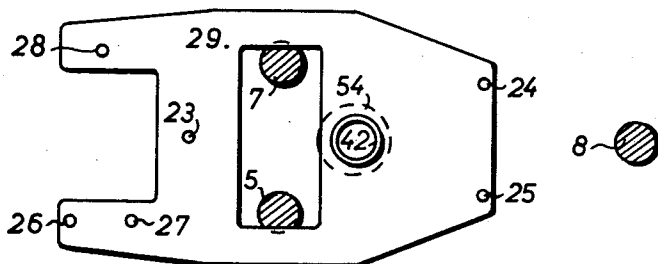
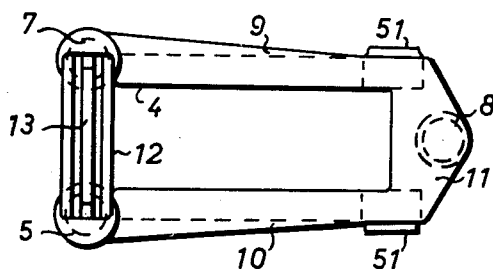
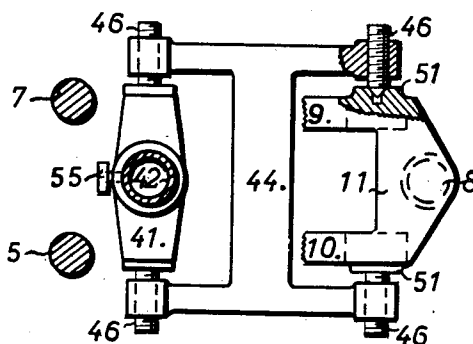


Fig. 7.

Fig. 8.



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UNITED STATES PATENT OFFICE

2,581,807

ANALYTICAL BALANCE

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In Switzerland May 17, 1950

11 Claims. (Cl. 265—54)

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This invention relates to an analytical balance and more particularly to a micro-balance, comprising a carrier, a counter-bearing on the carrier for supporting the centre knife edge of the balance beam during operation and an arrestment for relieving the knife edges on said balance beam from load, the arrestment including one or more movable parts provided with lifting members to lift the balance beam from said counter-bearing and to lift the pan system from the corresponding knife edges on the balance beam when the balance is not in use.

Objects of the invention are to provide an analytical balance of the type stated in which the arrestment includes a movable part directly provided with lifting members to lift the balance beam and the pan system suspended on the balance beam, a plurality of articulated levers for guiding said movable part, and adjustable conical bearings with which said articulated levers are arranged one above the other and linked on the one hand to said carrier and on the other hand to said movable part, whereby a smooth up and down movement and a playless guiding of said lifting members may be achieved. Objects are to provide, in an analytical balance of the type stated, articulated levers arranged one above the other for guiding a movable part of the arrestment, one of these levers being linked to the foot portion of a carrier and another to the head portion of said carrier, said head portion being equipped with the counter-bearing to support the centre knife edge of the balance beam and the foot portion of said carrier bearing directly on the pedestal of the balance; the pedestal being provided with an operating arrangement comprising a push rod articulated on the one hand to said movable part and coupled on the other hand with manually operable means for moving the arrestment. A further object is to provide an analytical balance of the kind outlined and including a double pan system each part of which being suspended on a corresponding outer knife edge on the balance beam, and an arrestment for relieving of load the said knife edges; the arrestment comprising a movable part directly provided with two sets of lifting members to lift the double pan system from the knife edges of the balance beam, a movable part directly provided with a set of lifting members to lift the centre knife edge of the beam from the counter-bearing on the carrier of the balance, two pairs of articulated levers for guiding said movable parts, bearings with which each of said levers are linked on the one hand to said carrier and on the other

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hand to the corresponding movable part, and manually operable means comprising a rotatable shaft equipped with two eccentrics of unequal eccentricity, the movable part of the arrestment which is provided with the two sets of lifting members to lift the double pan system being moved by the eccentric having the greater eccentricity, and the movable part of the arrestment which is provided with the set of lifting members to lift the balance beam being moved by the eccentric having the smaller eccentricity. Yet another and more specific object is a micro-balance of the character described and comprising a carrier, a counter-bearing mounted thereon, a single pan system suspended on an outer knife edge on one arm of the balance beam, a fixed counter-weight mounted on the other arm of the balance beam and an arrestment for relieving the said two knife edges from load, the arrestment including only one movable part directly provided with the lifting members to lift the asymmetrical beam from the counter-bearing and with lifting members to lift the single pan system from the outer knife edge on said beam, a pair of articulated levers for guiding said movable part, bearings with which the articulated levers are arranged one above the other and linked on the one hand to said carrier and on the other hand to said movable part, and manually operable means including a rotatable drive shaft and an eccentric mounted thereon for moving said arrestment.

These and other objects and the advantages of the invention will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing, wherein like reference characters indicate like parts throughout the several figures and in which:

Fig. 1 shows a constructional form of an analytical balance having a symmetrical beam and two pans which are suspended from the two outer knife edges of the beam;

Figures 2 to 4 show in plan view separate parts of the balance shown in Fig. 1;

Fig. 5 shows a further constructional form of a micro-balance having an asymmetrical beam, in which one pan is suspended only from one arm of the beam on the outer knife edge thereof, while the other arm of the beam is provided with a fixed counter-weight, and

Figures 6 to 8 show in plan view separate parts of the balance shown in Fig. 5.

In the balance shown in Figures 1 to 4, there is secured to the base plate 1 of the pedestal 2,

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which is shown in section, a carrier consisting of a plate-like foot portion 3, a head portion 4—separately shown in Fig. 2—and pillars 5, 6, 7 and 8 rigidly secured thereto. The foot portion 3 of the carrier, like the base plate 1, is shown partly in section, and the pillars 5 and 6 above the base plate 1 are accordingly shown in fragmentary form. The carrier consisting of the foot portion 3, the pillars 5 to 8 and the head portion 4 may be either made in one piece or assembled from the various parts shown by screwing. The head portion 4 of the carrier consists (Fig. 2) of two downwardly bent projecting arms 9 and 10, which are connected together by tie bars 11 and 12. Mounted on the tie bar 12 (Figures 1 and 2) is the bearing 13 for supporting during operation the centre knife edge 14 of the beam 15. The suspension system (Fig. 1) consisting of two identical parts is hung on the two outer knife edges 16 and 16' of the beam. Each part of the suspension system contains a pan 17, 17', a supporting link 18, 18', a supporting stirrup 19, 19' (shown broken through for the sake of clarity), a supporting plate 20, 20' and a plane bearing 21, 21'. The beam 15 also has two extensions 22 and 22' extending perpendicularly to the drawing plane (Fig. 1), which have recessed guideways (not shown) in which the lifting pins 23, 24, 25 engage in the arrested position of the beam in the manner of the known three-point support (Figures 1 and 3). The supporting plates 20 and 20' also have recessed guideways (not shown) in which the lifting pins 26, 27, 28 and 26', 27', 28' (Figures 1 and 4) engage when the suspension system is in the arrested position, also in the manner of a three-point support.

The lifting pins 23, 24, 25 serving to arrest the beam 15 are mounted on an upwardly bent plate-like portion 29, the form of which will be seen from Figures 1 and 3. The bent-over plate 29 is mounted in turn on a flange 30 which extends laterally between the pillars 5 and 7 on the one hand and the pillars 6 and 8 on the other hand (Fig. 3). Furthermore, the flange 30 is connected to the rod 31 which extends between the pillars 5 to 8 in a direction parallel to the said pillars. The bent-over plate 29, the flange 30 and the rod 31 form that movable part of the arrestment which is provided for lifting the beam 15, and which is provided at the lower end of the rod 31 with a further flange 32, which may be of identical construction to the upper flange 30. This movable part 29 to 32 of the arrestment is guided by two articulated levers 33 and 34 preferably of identical form. In Fig. 3, the articulated lever 34 is shown in plan view in which the H-form thereof can be seen. The two articulated levers 33 and 34 have at their free ends screws 35, the forward portions of which are conical and by means of which they are movably linked on the one hand to the flanges 30 and 32 of the movable part of the arrestment and on the other hand to the projecting arms 9 and 10 of the head portion 4 and to the nose-like extensions 36 of the foot portion 3 of the support. The screws 35 engage in suitably fashioned conical guideways provided in the flanges 30 and 32, in the projecting arms 9 and 10 and in the nose like extensions 36 of the foot portion (Figures 1 to 3). The screws 35 are also provided with lock nuts (not shown), by means of which the screws 35 are fixed in the usual way in the position to which they are adjusted. The screws 35 and the suitably fashioned conical

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recesses in the counter-bearings may naturally be replaced by adjustable conical bearings of other form, by which the articulated levers 33 and 34 are articulated to the carrier and to the movable part of the arrestment. The conical bearings may be snugly tightened so that the movable part 29 to 32 and consequently the lifting pins 23, 24, 25 have no play either in the direction parallel to the knife edge 14 of the beam or in the direction parallel to the beam arms when moving upwardly or downwardly. When the arrestment is released, that is, when the movable part 29 to 32 is lowered, the knife edge 14 of the beam 15 is thus always brought to rest on the plane bearing 13 in exactly the same way. In order also to obtain a smooth movement of the movable part 29 to 32 when the screws 35 are firmly tightened, there is articulated to the lower end of this part, i. e. to the flange 32, a push rod 37 which is positively moved by an operating shaft 38 and an eccentric 39 mounted thereon.

Similarly, the arrestment has a further movable part 40, 41, 42, 43, on which are directly provided the lifting pins 26, 27, 28 and 26', 27', 28' provided for lifting the suspension system. The said lifting pins are mounted on an upwardly bent plate-like part 40 which is secured by the flange 41 (Figures 1, 4) to the tube 42, which has on its lower end a further flange 43. The two flanges 41 and 43, which are of identical form, can be movably clamped on the tube 42, the flange 41 projecting laterally between the pillars 5, 7 and 6, 8, as shown in Fig. 4. This further movable part 40 to 43 of the arrestment is guided by two articulated levers 44 and 45, which are situated one below the other and preferably have equal dimensions, in the same way as the articulated levers 33 and 34. The levers 44 and 45 are movably articulated by means by conical bearings on the one hand to the flanges 41 and 43 and on the other hand to the tie bar 11 (Fig. 4) and to the nose-like extensions 36 of the foot portion 3. The adjustable conical bearings are represented by screws 46, the front portions of which are conical and which engage in corresponding recesses in the flanges 41 and 43 and in the extensions 36, as also in the tie bar 11 (Figures 1 and 4). Also articulated to the lower flange 43 is a push rod 47 (Fig. 1), which is positively moved by the eccentric 48. The screws 46 may also be firmly tightened, so that the movable part 40 to 43 has no play either in the direction parallel to the arms of the beam 15 or in the direction parallel to the knife edges 14, 16 and 16' when moved about the fixed pivot points of the levers 44 and 45. The two eccentrics 39 and 48 mounted on the drive shaft 38 preferably have equal diameter, but are mounted with different eccentricity on the shaft 38, the eccentricity of the eccentric 48 being greater than that of the eccentric 39, so that the amplitude of movement of the part 40 to 43 is accordingly greater than that of the part 29 to 32 when the shaft 38 is rotated. The drive shaft 38, which is only partially shown, is mounted on the one hand in a rib-like extension 49 provided on the foot portion 3 and on the other hand in a plain bearing (not shown) situated on the forward portion of the pedestal 2, and has on its part projecting beyond the pedestal 2 the usual operating knob (also not shown) by which the whole arrestment is actuated.

The length of the lifting pins 23 to 25, on the one hand and that of the lifting pins 26 to 28 and 26' to 28' on the other hand is such that when

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the eccentrics 39 and 48 are in the uppermost position the centre knife edge 14 of the beam is lifted from the counter-bearing 13 and the plane bearings 21 and 21' are lifted from the outer knife edges 16 and 16' of the beam. When the arrestment is released by rotation of the shaft 38, the suspension system provided with the pans 17 and 17' is put on the outer knife edges 16 and 16' of the beam and is thereafter released by the lifting pins 26 to 28 and 26' to 28'. The beam 15 then still lies on the lifting pins 23 to 25. Thus, the suspension system is always laid in exactly the same manner on the outer knife edges 16 and 16'. On further rotation of the shaft 38, all the lifting pins descend further until the centre knife edge 14 also is put on the plane bearing 13. The position thus occupied by the beam, the suspension system and the arrestment is shown in Fig. 1. Finally, if the shaft 38 is turned until the eccentrics 39 and 48 occupy their lowermost position, the pins 23 to 25 also release the beam which then rocks freely about its zero position on the centre knife edge 14, provided that the pans 17 and 17' are not loaded. Conversely, on turning the shaft 38 to carry the eccentrics 39 and 48 to their uppermost positions, the beam is first lifted from the bearing 13 and then the outer knife edges 16 and 16' are relieved of load by lifting of the entire suspension system.

Particular attention is called to the fact, that the up and down movement of the movable part of the arrestment has hitherto usually been guided by means of plain bearings situated in a central pillar of the balance. The movement of the arrestment, which takes place vertically, must take place easily and without the slightest hindrance, as otherwise rebounding and even damage to the knife edges of the beam may occur on release of the arrestment, that is, when the centre knife edge is put on the counter-bearing and when the pan system is put on the outer knife edges. A certain, very small play is therefore unavoidable in the said plain bearings if the movable part of the arrestment is to be capable of moving smoothly up and down. The lateral component of this play, which is in the direction of the arms of the beam, results however in the counter-bearings of the pan system never being applied in exactly the same manner to the outer knife edges of the beam. More especially, the said counter-bearings are not always applied exactly at their centre, so that they occupy a slightly inclined position, which varies in each instance. This variable inclination of the bearings of the suspension system produces variable active leverages on the beam owing to the small, but unavoidable width of the edge of the outer knife edges on the beam, whereby the accuracy of the balance is obviously impaired. If, on the other hand, the up and down movement of the various parts of the arrestment is guided by articulated levers 33, 34 and 44, 45 as shown in Figures 1 to 4, the playless guiding of the movable parts of the arresting arrangement ensures that the length of the effective arms of the beam, i. e. the distance between the lines along which the counter-bearings 13, 21, 21' lie against the corresponding knife edges 14, 16, 16', remain constant with great precision, whereby the accuracy of the balance is accordingly increased. Moreover, the knife edges of the beam are preserved because if the articulated levers are suitably arranged, the counter-bearings 13, 21, 21' can be put on the corresponding knife edges in an exactly vertical direction.

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The use of the movable parts of the arresting arrangement which are guided by articulated levers is especially advantageous in the case of balances which have a beam having unequal arms, the entire suspension system being suspended from one arm of the beam, while a constant counter-weight is secured to the other arm. In such balances, which can more especially be constructed as micro-balances, both the article to be weighted and the weights are laid on the one pan, so that the beam is always under a constant load when in its zero position. Since in such balances the length of the effective arm of the beam which is provided with the counter-weight is constant in itself, it only remains to ensure that the effective length of the other beam arm provided with the single pan system remains constant. As will hereinafter be described with reference to Figures 5 to 8, such a balance only requires for the arrestment a single movable part which is guided by articulated levers arranged one above the other and on which all the lifting pins required for the arrestment of the suspension system and for the arrestment of the beam may be provided. It is obvious that a considerable saving of structural elements is thus effected and the construction of the whole balance becomes simple and compact.

The micro-balance shown in Figures 5 to 8 has a pedestal 2, on the base plate 1 of which inwardly projecting ribs 50 are provided, which serve as a bearing for the drive shaft 38 of the arrestment. In Fig. 5, only one of these ribs 50 is shown, and the shaft 38 is only partly illustrated, while that part of the shaft which extends beyond the wall of the pedestal, and the operating button have been omitted for the sake of clarity. Mounted on the base plate 1—shown in section—of the pedestal 2 is the carrier, which consists of a plate-like foot portion 3, a head portion 4 (shown in fragmentary form in Fig. 6) and the pillars 5, 7, 8. The foot portion 3 of the carrier is shown partially in section and the forward pillar 5 is accordingly shown in fragmentary form (Fig. 5). The head portion 4 of the carrier (Fig. 6) consists of the two arms 9 and 10 and the cross members 11 and 12. As will be seen from the plan view of this head portion shown in Fig. 6, this head portion is in the form of a flat frame, the cross member 12 which extends above the arms 9 and 10 supporting the counter-bearing 13 for the knife edge 14 of the beam 15 (Fig. 5). The other cross member 11 has downwardly extending projections 51, which are situated exactly above the upwardly directed projections 36 of the foot portion. In operation, the centre knife edge 14 of the beam 15 bears against the plane bearing 13, the left arm of the beam having an outer knife edge 16, on which is suspended the entire suspension system, which consists of the counter-bearing 21, the bearing plate 20, the supporting stirrup 19, the supporting links 18 and the pan 17. The stirrup 19 is shown only in fragmentary form for the sake of clarity. The right-hand longer arm of the beam is provided with a fixed counter-weight 52 and an extension 22 perpendicular to the plane of the drawing (Fig. 5), while the left-hand shorter arm has a pin-like thickening 53. The extension 22 and the thickening 53 have on their lower faces recessed guideways (not shown), in which the set of lifting pins 23, 24, 25 engage to form a three-point mounting (Fig. 7) when the beam 15 is in the arrested position. The bearing plate 20 also has such recessed guide-

ways (not shown), in which the lifting pins 26, 27, 28 similarly engage in the form of a three-point mounting (Fig. 7) when the suspension system is in the arrested position. The said sets of lifting pins are all arranged on a common plate-like part 29 (Figures 5 and 7) in which a recess is formed, the said part being rigidly secured to a flange 54, which is in turn rigidly secured to a tube 42. Moreover, two further flanges 41 and 43 are adjustably clamped to the tube 42 by means of set screws 53. Of the two flanges, which are identical, the upper flange 41 is shown in plan view in Fig. 8. The plate 29, the flanges 41, 43, 54 and the tube 42 thus constitute the movable part of the arrestment, guided by means of the two articulated levers 44 and 45 (Fig. 5) arranged one above the other. The H-shaped levers 44 and 45 have on their free arms screws 46 which are conical at their forward ends, and are linked on the one hand to the flanges 41 and 43 and on the other hand to the projections 51 and 36 without play in the manner already described, so that the tube 42 and consequently the entire movable part of the arrestment can be moved up and down in the manner of an parallelogram-like guiding. A push rod 47 engaging in the bottom of the tube 42 transmits through the pin 56 and the eccentric 48 the movements determined by the rotation of the drive shaft 38.

When the eccentric 38 is in the uppermost position, the centre knife edge 14 is lifted from the counter-bearing 13 and the beam 15 rests on the lifting pins 23 to 25. The other lifting pins 26 to 28 are so much longer that when the beam 15 is arrested the counter-bearing 21 is lifted from the knife edge 16 and the pan system 17 to 21 lies on the lifting pins 26 to 28. In this arrested position, however, the distance between the lifted knife edge 14 and the counter-bearing 13 and the distance between the lifted counter-bearing 21 and the knife edge 16 only amount to a few tenths of a millimetre. When the arrestment is removed, i. e. the eccentric 48 is turned towards its lowermost position, the centre knife edge 14 is simultaneously deposited on the counter-bearing 13 and the suspension system is deposited on the knife edge 16. The lifting pins then descend further and the pins 26 to 28 completely release the suspension system, the pin 23 also being retracted from the left-hand arm of the beam. However, when the pan 17 is unloaded, the right-hand arm of the beam 15 continues to rest on the two lifting pins 24 and 25 and simultaneously on its centre knife edge 14, owing to the action of the counter-weight 52. This position is shown in Fig. 5. A similar position is obviously also obtained when the eccentric 48 is in the lowermost position, with the difference that all the lifting pins have been moved somewhat further downwards and the beam has turned slightly in the clockwise direction on the knife edge 14. Moreover, the required movement during the engagement or disengagement of the arrestment can be permanently adjusted by suitable adjustment of the flanges 41 and 43 along the tube 42 by means of the screws 55.

The playless guiding of that part of the arrestment which carries the lifting pins also makes it possible in the balance shown in Figures 5 to 8 to make the left-hand arm of the beam of the required length, since the suspension system is always applied in exactly the same manner with respect to the two knife edges of the beam. The accuracy of the balance is accord-

ingly high. It is especially desirable that the carrier consisting of the heading and foot portions and the pillars may be readily constructed as a very rigid structure and can be mounted on the pedestal of the balance in one piece. Since those parts of the arrestment which carry the lifting pins are also articulated to the rigid carrier, scarcely any influence can be exerted on the movements during the operation of the arrestment once they have been adjusted, so that for this reason also the accuracy of the balance is rendered substantially independent of external mechanical action as for example mild shocks and the like.

The invention is not limited to the particular embodiments herein shown and described. For a balance having a high accuracy it may be advisable to provide a housing which encloses the beam and the suspension system. This and other modifications which may occur to those familiar with the art fall within the spirit and scope of the invention as set forth in the following claims.

We claim:

1. An analytical balance, comprising a balance beam, a pan system, said balance beam having a centre knife edge for its support and an outer knife edge for suspension of the pan system therefrom, a carrier, a counter-bearing on said carrier for supporting the centre knife edge of the balance beam during operation, and an arrestment for relieving the knife edges on said balance beam from load, said arrestment including a movable part directly provided with lifting members to lift the pan system suspended on the balance beam, articulated levers for guiding said movable part, and bearings with which said articulated levers are arranged one above the other and linked on the one hand to said carrier and on the other hand to said movable part.

2. The invention as recited in claim 1, wherein each of said articulated levers is linked on the one hand to the associated movable part of the arrestment by means of a pair of adjustable conical bearings and on the other hand to said carrier by means of a second pair of adjustable conical bearings.

3. The invention as recited in claim 2, wherein the spindles of said adjustable conical bearings extend horizontally and the articulated levers extend at least approximately parallel to the direction of the balance beam.

4. The invention as recited in claim 1, in combination with a pedestal for supporting said balance, and wherein one of said articulated levers arranged one above the other is linked to the foot portion of said carrier and another to the head portion of said carrier, the head portion of said carrier being provided with the counter-bearing for supporting the centre knife edge of the balance beam and the foot portion of said carrier bearing on the pedestal of the balance.

5. The invention as recited in claim 4, wherein the pedestal of the balance is provided with an operating arrangement comprising a push rod articulated on the one hand to said movable part provided with lifting members and coupled on the other hand with manually operable means for moving said arrestment.

6. The invention as recited in claim 1, wherein said movable part of the arrestment comprises a plate-like head portion to which said lifting members are directly secured, a rod extending at least approximately parallel to the direction

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of said carrier and secured to said head portion, and two flanges fastened to said rod, each of said flanges being linked by means of a pair of bearings to one of said articulated levers lying one above the other.

7. the invention as recited in claim 6, wherein at least one of said flanges is detachably clamped to said rod.

8. An analytical balance, comprising a double-armed balance beam having a centre knife edge and outer knife edge, a carrier, a counter-bearing on said carrier for supporting the centre knife edge of the balance beam, a double pan system each part of which being suspended on a corresponding outer knife edge mounted on the two arms of the balance beam, and an arrestment for relieving the said three knife edges from load, said arrestment including a movable part directly provided with two sets of lifting members to lift the double pan system from the corresponding knife edges of the balance beam, a further movable part directly provided with a set of lifting members to lift the balance beam from said counter-bearing, two pairs of articulated levers for guiding the respective movable parts, and bearings with which each of said articulated levers is linked on the one hand to said carrier and on the other hand to the corresponding movable part.

9. The invention as recited in claim 8, in combination with manually operable means for moving said arrestment, said means including a rotatable shaft equipped with two eccentrics of unequal eccentricity, the movable part of the arrestment which is provided with the two sets of lifting members to lift the double pan system being moved by the eccentric having the greater

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eccentricity and the movable part of the arrestment which is provided with the set of lifting members to lift the balance beam being moved by the eccentric having the smaller eccentricity.

10. An analytical balance, comprising a double-armed balance beam having a centre knife edge and an outer knife edge on one of its arms, a carrier, a counter-bearing on said carrier for supporting the centre knife edge of the balance beam during operation, a single pan system suspended on said outer knife edge mounted on one arm of the balance beam and a fixed counterweight mounted on the other arm of the balance beam, and an arrestment for relieving the said two knife edges from load, said arrestment including only one movable part directly provided with the lifting members to lift the beam from the counter-bearing and with lifting members to lift the pan system from the outer knife edge on the beam, a pair of articulated levers for guiding said movable part, and bearings with which said articulated levers are arranged one above the other and linked on the one hand to said carrier and on the other hand to said movable part.

11. The invention as recited in claim 10, in combination with manually operable means for moving said arrestment, said means including a rotatable shaft, and an eccentric mounted on said shaft for actuating the movable part of the arrestment.

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No references cited.