PATENT SPECIFICATION

667,948

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COMPLETE SPECIFICATION

Improvements in or relating to Analytical Balances

I, ERHARD METTLER, a Swiss citizen, trading as E. METTLER, FABRIK FÜR ANALYSENWAAGEN, of Untere Heslibachstrasse 46, Küsnacht, Zürich, Switzerland, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to analytical balances.

In analytical balances and especially in micro-balances, an arrestment is provided, by which the knife edges mounted on the beam can be relieved of load when the balance is not in use. Such an arrestment comprises a movable part on which are provided members for lifting the beam from the centre bearing and further members for lifting the suspension system from the outer knife edge or edges of the beam. This movable part of the arrestment, with the lifting members, has hitherto usually been mounted in plain bearings situated in the central pillar of the balance. The movement of the movable part 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 mounted on the bearing and when the suspension system is mounted 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 bearings of the suspension system never being applied with complete accuracy to the outer knife edges of the beam. More especially, the bearings are not applied exactly at their centre, so that they always occupy a slightly inclined position, which varies in each instance. This variable inclination of the bearings produces variable active leverages on the beam owing to the small but unavoidable width of the sides of the knife edges, whereby the accuracy of the balance is obviously impaired.

The present invention aims at obviating the aforesaid inaccuracies produced in an analytical balance by the arrestment. This is achieved, more especially in a micro-balance comprising an arrestment for relieving of load the knife edges provided on the beam in which lifting members are provided for lifting the beam and further lifting members are provided for lifting the suspension system, by providing in the arrestment a movable part on which lifting members are directly mounted and by guiding this movable part by means of articulated links arranged one above the other.

Embodiments of the present invention are diagrammatically illustrated in Figures 1 to 8 of the accompanying drawings, in which:

Figure 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 full, in plan view, separate parts of the balance shown in Figure 1,

Figure 5 shows a further constructional form of an analytical 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 Figure 5.

In the balance shown in Figures 1 to 4, there is secured to the base plate 1 of the pedestal 2, which is shown in section, a carrier consisting of a plate-like foot

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Price 25p

portion 3, the pillars 5, 6, 7 and 8 rigidly secured thereto and the head portion 4, which is separately shown in Figure 2. 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 of two downwardly bent projecting arms 9 and 10, which are connected together by cross members 11 and 12. Mounted on the cross member 12 (Figure 1 and 2) is the bearing 13 for supporting during operation the centre knife edge 14 of the beam 15. The suspension system consisting of two identical parts is hung on the two outer knife edges 16 and 16^1 of the beam. Each part of the suspension system contains a pan 17, 17^1, a supporting link 18, 18^1, a supporting stirrup 19, 19^1 (shown broken through for the sake of clarity), a supporting plate 20, 20^1 and a bearing 21, 21^1. The beam 15 also has two extensions 22 and 22^1 extending perpendicularly to the drawing plane (Figure 1), which have recessed guideways (not shown) in which the lifting pins 23, 24, 25 engage in the arrested position of the beam 15 in the manner of the known three-point support (Figures 1 and 3). The supporting plates 20 and 20^1 also have recessed guideways (not shown) in which the lifting pins 26, 27, 28 and 26^1, 27^1, 28^1 (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 (Figure 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 arresting the beam 15, and which supports at the lower end of the rod 31 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 guide links 33 and 34 preferably of identical form. In Figure 3, the articulated link 34 is shown in plan view in which the **H**-form thereof can be seen. The two articulated links 33 and 34 have at their free ends screws 46, 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 46 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 46 are also provided with lock nuts (not shown), by means of which the screws 46 are fixed in the usual way in the position to which they are adjusted. The screws 46 and the suitably fashioned conical recesses in the counter-bearings may naturally be replaced by adjustable conical bearings of other form, by which the articulated guide links 33 and 34 are articulated to the carrier and to the movable part of the arrestment. The conical bearings and the screws 46 may be fully tightened so that the movable part 29 to 32 and consequently the lifting pins 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 bearing 13 in exactly the same way. In order also to obtain a smooth movement of the movable part 29 to 32 when the bearings and the screws 46 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 eccentric 39 mounted on the operating shaft 38.

Similarly, the arrestment has a further movable part 40, 41, 42, 43, on which are directly provided the lifting pins 26, 27, 28 and 26^1, 27^1, 28^1 provided for lifting the suspenson system. The said lifting pins are mounted on an upwardly bent plate-like part 40 which is secured by the flange 41 (Figures 1 and 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 Figure 4. This further movable part 40 to 43 of the arrestment is guided by two articulated guide links 44 and 45, which

are situated one below the other and have equal dimensions, in the same way as the articulated links 33 and 34. The articulated links 44 and 45 are movably articulated by means of conical bearings on the one hand to the flanges 41 and 43 and on the other hand to the cross member 11 (Figure 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 cross member 11 (Figures 1 and 4). Also articulated to the lower flange 43 is a push rod 47 (Figure 1), which is positively moved by the eccentric 48. The movable conical bearings, to which the articulated links 44 and 45 are linked, may also be fully tightened, so that the movable part 40 to 43 also has no play either in the direction parallel to the arms of the beam or in the direction parallel to the knife edges 14, 16, 16^1 when moved about the fixed pivot points of the links 44 and 45.

The two eccentrics 39 and 48 mounted on the operating shaft 38 preferably have external paths of equal diameter, but are mounted with different eccentricity on the shaft 38. More especially, the eccentricity of the eccentric 48 is 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 shaft 38, which is only partially shown, is mounted on the one hand in a rib-like extension 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 26^1 to 28^1 on the other hand is such that when the eccentrics 39 and 48 are in the uppermost position the centre knife edge 14 of the beam 15 is lifted from the bearing 13 and the bearings 21 and 21^1 are lifted from the outer knife edges 16 and 16^1 of the beam. When the arrestment is released by rotation of the shaft 38, the suspension system provided with the pans 17 and 17^1 rests on the outer knife edges 16 and 16^1 and is thereafter released by the lifting pins 26 to 28 and 26^1 to 28^1. The beam 15 then still lies on the lifting pins 23 to 25. Thus, the suspension is always laid in exactly the same manner on the outer knife edges 16 and 16^1. On further rotation of the shaft 38, all the lifting pins descend further until the centre knife edge 14 also bears on the bearing 13. The position thus occupied by the beam and the arrestment is shown in Figure 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 17^1 are not loaded. Conversely, on arresting the balance, the beam is first lifted from the bearing 13 and the outer knife edges 16 and 16^1 are relieved of load by lifting of the entire suspension system. The playless guiding of the two movable parts of the arresting arrangement which are provided with the two sets of lifting pins ensures that the lengths of the effective arms of the beam, i.e. the distances between the lines along which the bearings lie against the knife edges, remain constant with great precision, whereby the precision of the balance is accordingly increased. Moreover, the knife edges are preserved because if the articulated links are suitably arranged, the bearings can be mounted on the outer knife edges, and the centre knife edge on the bearing pin 13, in an exactly vertical direction.

The use of the movable parts of the arresting arrangement which are guided by articulated guide links 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 the zero position. Since in such balances the length of the effective beam 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 outer knife edge remains constant, and is not varied when the suspension means are placed in position. 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 links 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 con-

struction of the whole balance becomes simple and compact.

The balance shown in Figures 5 to 8 has a pedestal 2, on the base plate 1 of which inwardly projecting ribs 54 are provided, which serve as a bearing for the operating shaft 38 of the arrestment. In Figure 5, only one of these ribs 54 is shown, and the shaft 38 is only partly illustrated, while that part of the shaft which extends beyond the end 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 Figure 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 (Figure 5). The head portion 4 of the carrier (Figure 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 Figure 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 bearing. The other cross member 11 has downwardly extending projections 55, 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 bearing 13, the left arm of the beam having an outer knife edge 16. On this outer knife edge is suspended the entire suspension system, which consists of the 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 50 and with an extension 22 perpendicular to the plane of the drawing (Figure 5), while the left-hand shorter arm has a pin-link thickening 56. The extension 22 and the thickening 56 have on their lower faces recessed guideways (not separately shown), in which the lifting pins 23, 24, 25 engage to form a three-point mounting (Figure 7) when the beam 15 is in the arrested position. The bearing plate 20 also has such recessed guideways, in which the lifting pins 26, 27, 28 similarly engage in the form of a three-point mounting (Figure 7) when the suspension system is in the arrested position. The said 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 51, which is in turn rigidly secured to a tube 42. Moreover, two further flanges 41 and 43 are adjustably screwed to the tube 42 by means of set screws 52. Of the two flanges, which are identical, the upper flange 41 is shown in plan view in Figure 8. The plate 29, the flanges 41, 43, 51 and the tube 42 thus constitute the movable part of the arresting arrangement, guided by means of the two articulated links 44 and 45 (Figure 5) arranged one above the other. The **H**-shaped articulated guide links 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 36 and 55 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 with a parallel motion. A push rod 47 engaging in the bottom of the tube 42 transmits through the pin 53 and the eccentric 48 the movements determined by the rotation of the operating shaft 38.

When the eccentric 38 is in the uppermost position, the centre knife edge 14 is lifted from the bearing 13 and the beam 15 rests on the lifting pins 23 to 25. The lifting pins 26 to 28 are so much longer that when the beam 15 is in the arrested position the bearing 21 is lifted from the outer knife edge 16 and the suspension 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 bearing 13 and the distance between the lifted bearing 21 and the knife edge 16 only amount to a few tenths of a millimetre. When arrestment is removed, i.e. the eccentric 48 is turned towards its lowermost position, the centre knife edge 14 is simultaneously deposited on the bearing 13 and the bearing 21 of 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, owing to the action of the counter-weight 50. This position is shown in Figure 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.

The playless guiding of that part of the arrestment arrangement 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 accordingly 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.

What I claim is:—

1. Analytical balance, especially a micro-balance, comprising an arrestment for relieving of load the knife edges provided on the beam, wherein lifting members are provided to lift the beam and further lifting members are provided to lift the suspension system, characterised in that the arrestment has a movable part on which lifting members are directly provided and that said movable part is guided by means of articulated links arranged one above the other.

2. Analytical balance as claimed in Claim 1, characterised in that a carrier is provided which supports the bearing by which the centre knife edge of the beam is supported during operation and that the articulated links arranged one above the other are linked on the one hand to the associated movable part of the arrestment and on the other hand to parts of the said carrier.

3. Analytical balance as claimed in Claim 2, characterised in that each of the articulated links 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 the said carrier by means of a pair of adjustable conical bearings.

4. Analytical balance as claimed in Claim 2, characterised in that the lifting members provided for lifting the suspension system are provided on a part of the arrestment which is guided by links arranged one above the other and the lifting members provided to lift the beam are provided on a second part of the arrestment which is guided by a second set of articulated links arranged one above the other.

5. Analytical balance as claimed in Claim 2, characterised in that in a balance having a suspension system provided only on one arm of the beam and a fixed counter-weight mounted on the other arm of the beam, the arrestment has only one movable part which is guided by means of articulated links arranged one above the other, and that both the lifting members for the suspension system and the lifting members for the beam are provided on this movable part.

6. Analytical balance as claimed in Claim 2, characterised in that one of the articulated links arranged one above the other is linked to the foot portion of the carrier and the other to the head portion of the carrier, and that the head portion of the carrier is provided with the bearing for supporting the centre knife edge of the beam during operation, while the foot portion of the carrier bears on the pedestal of the balance.

7. Analytical balance as claimed in Claim 4 and 6, wherein an operating arrangement for adjusting the arrestment is provided in the pedestal of the balance, characterised in that there is articulated to each of the movable parts of the arrestment, a push rod which is coupled with the operating arrangement and is moved thereby.

8. Analytical balance as claimed in Claim 3, characterised in that the spindles of the adjustable conical bearings extend horizontally and the articulated links extend at least approximately parallel to the direction of the beam.

9. Analytical balance as claimed in Claim 3, characterised in that the movable part of the arrestment is provided with lifting pins and has a plate-like head portion to which the lifting pins are directly secured, that the head portion is mounted on a rod extending at least approximately parallel to the direction of the carrier, and that there are secured to the rod two flanges to which the articulated links lying one above the other are linked by means of the adjustable conical bearings.

10. Analytical balance as claimed in Claim 7, characterised in that the push rods are moved positively by eccentrics mounted on a rotatable shaft provided with a handle, the said shaft being mounted in the pedestal of the balance.

11. Analytical balance as claimed in

Claims 4 and 10, characterised in that part of the arrestment is provided with lifting pins for the suspension system and is moved by an eccentric whose eccentricity is greater than the eccentricity of the eccentric by means of which that part of the arrestment which is provided with the lifting pins for the beam is moved.

12. Analytical balance as claimed in Claim 9, characterised in that at least one of the two flanges mounted on the rod with which the articulated links engage, is detachably clamped on the rod.

13. Analytical balance, constructed, arranged and adapted to operate, substantially as described with reference to the accompanying drawings.

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Agent for the Applicants.

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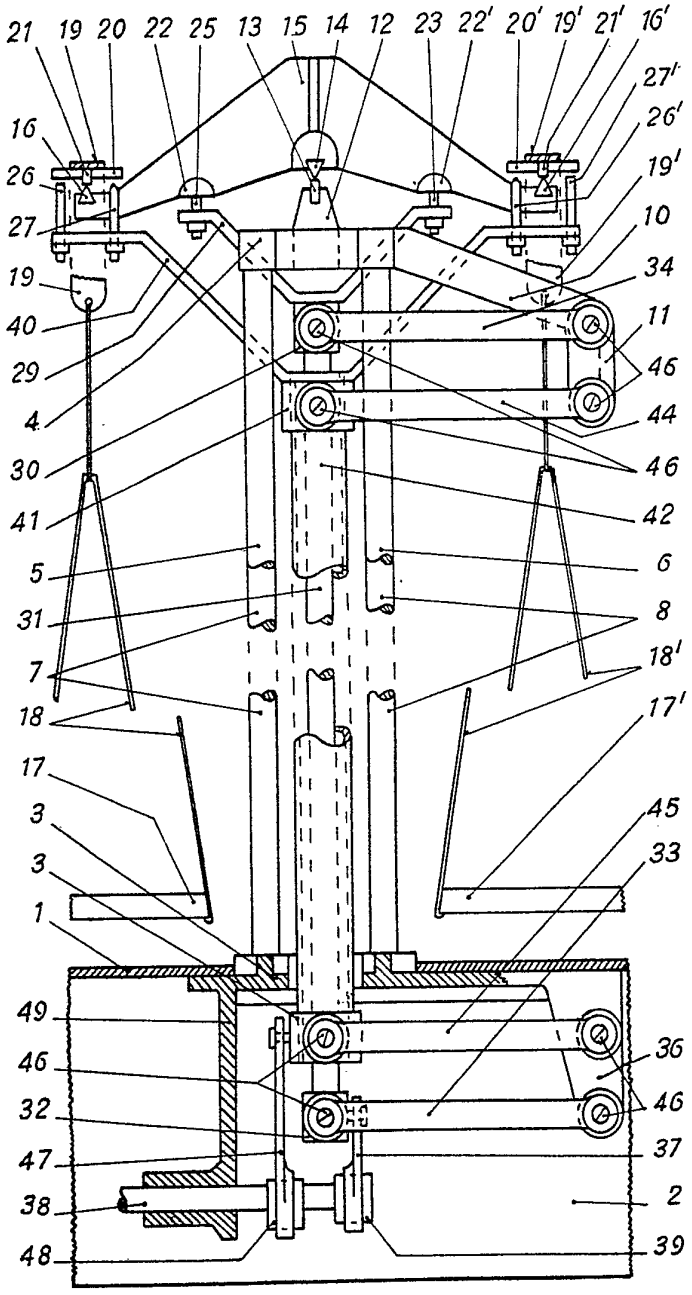

Fig.1.

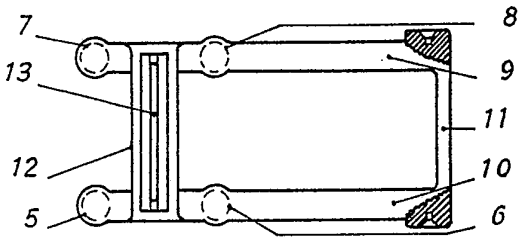

Fig.2.

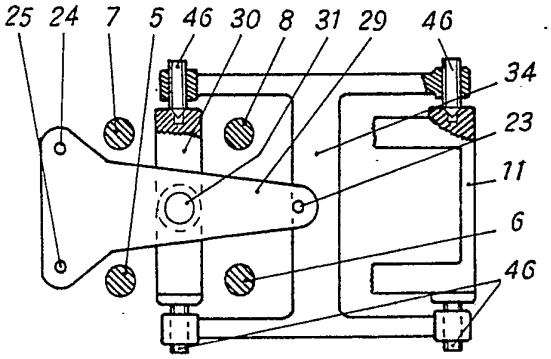

Fig.3.

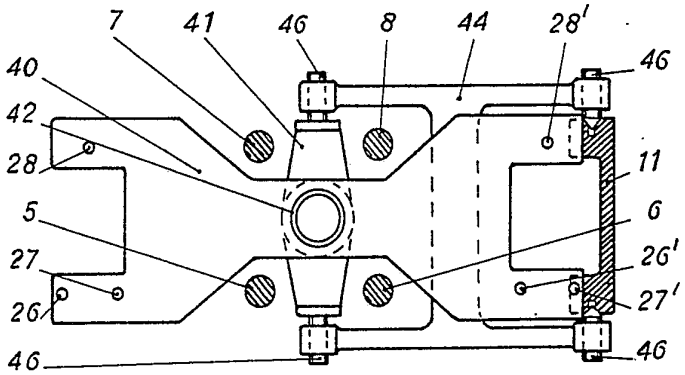

Fig.4.

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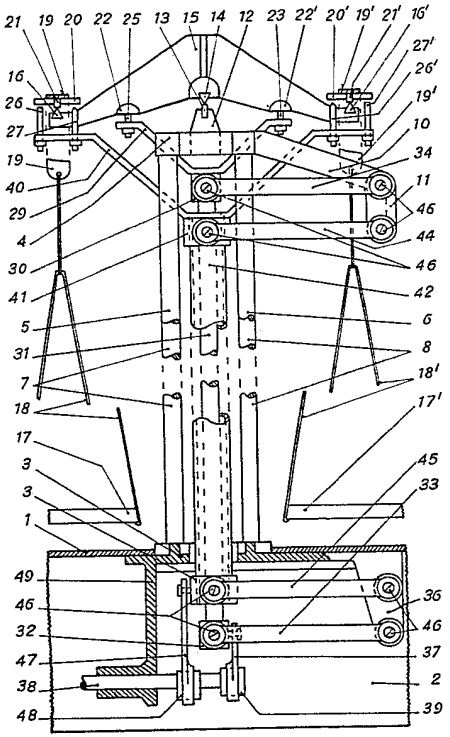

Fig.1.

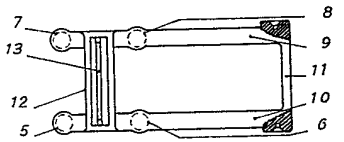

Fig 2.

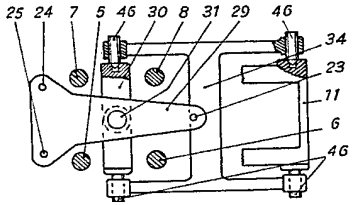

Fig.3.

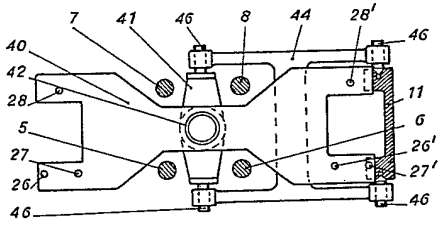

Fig.4.

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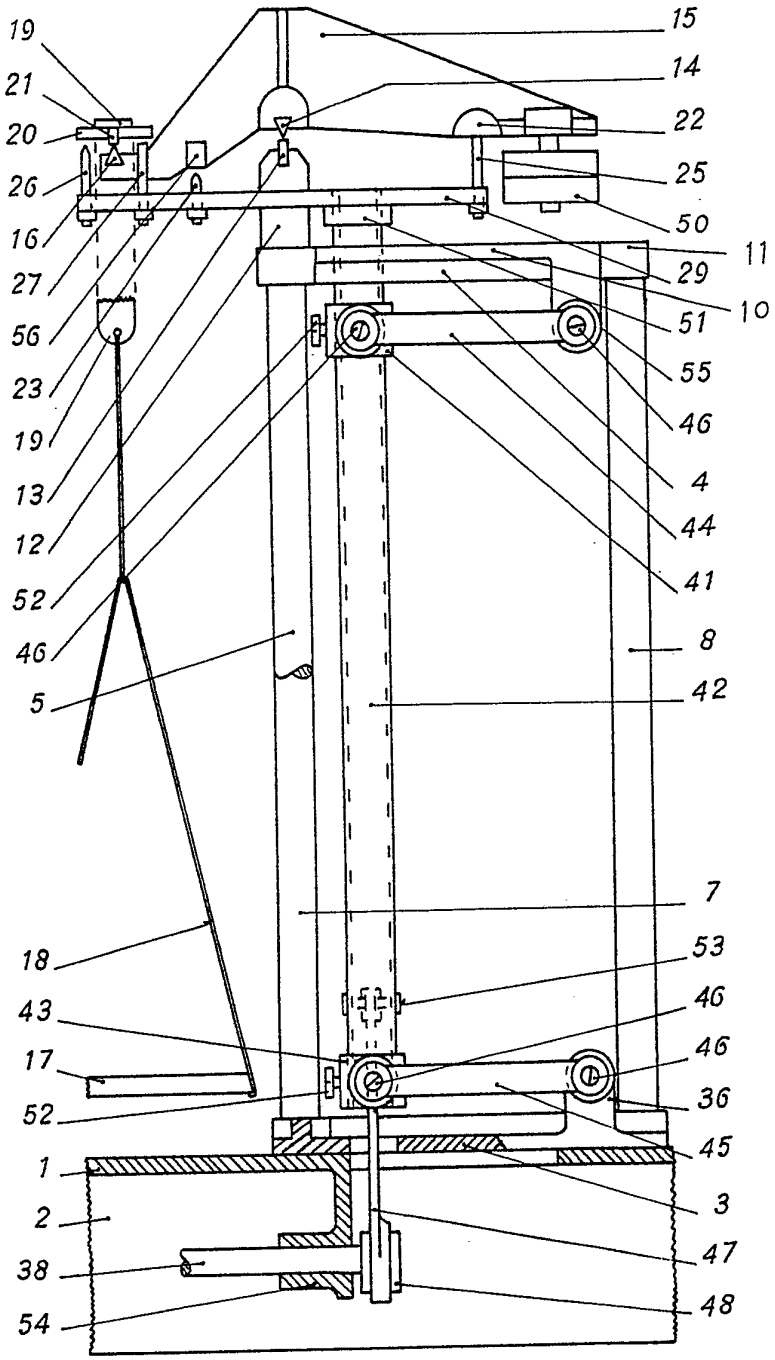

Fig. 5.

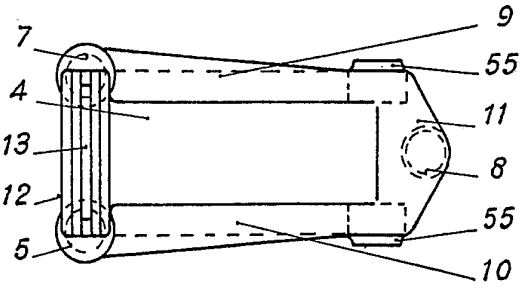

Fig. 6.

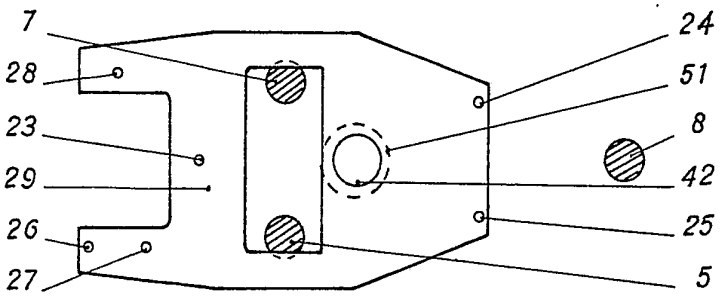

Fig. 7.

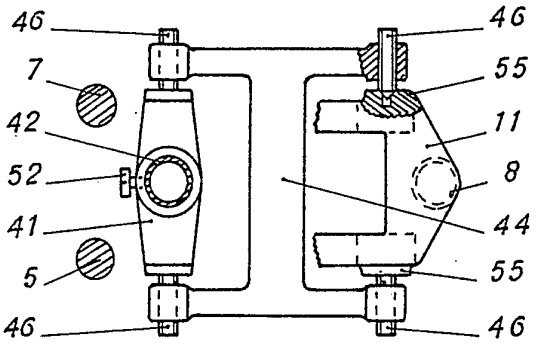

Fig. 8.

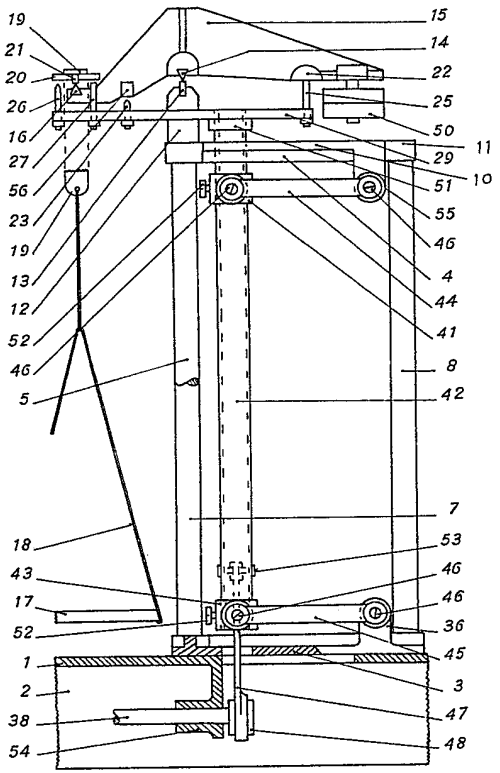

Fig. 5.

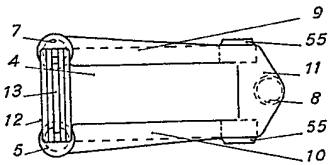

Fig. 6.

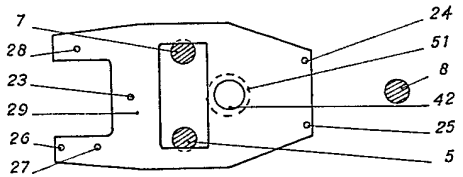

Fig. 7.

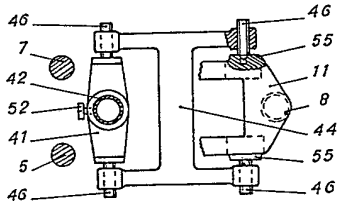

Fig. 8.

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