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(54) **CALIBRATION SYSTEM FOR A WEIGHING SCALE**

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(57) **ABSTRACT**

A lever system (**1, 7**) for a weighing scale has an electrical transducer, particularly a strain gauge (**14**), producing signals corresponding to the amount of the weighing load. The transducer is attached to a body (**1**) that is coupled to the lever system (**1, 7**). The lever system (**1, 7**) includes a means (**17**) for receiving a calibration weight (**18**) in an arrangement where the forces generated by the calibration weight (**18**) and/or a damper element (**5, 6**) are magnified.

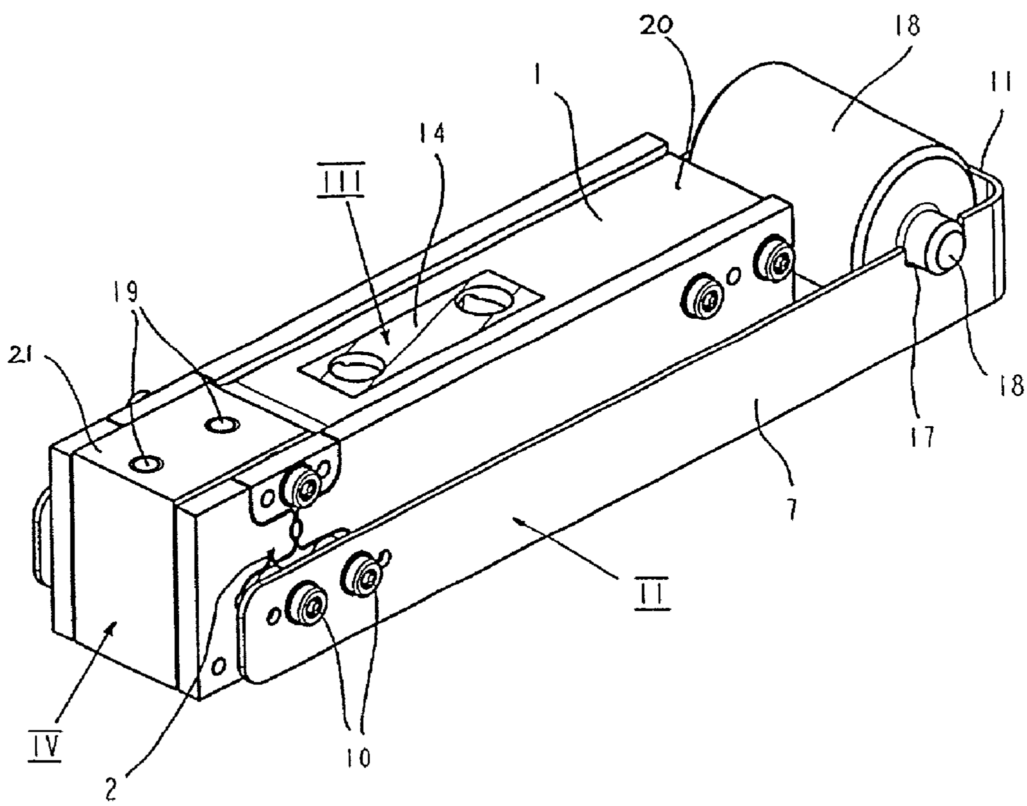
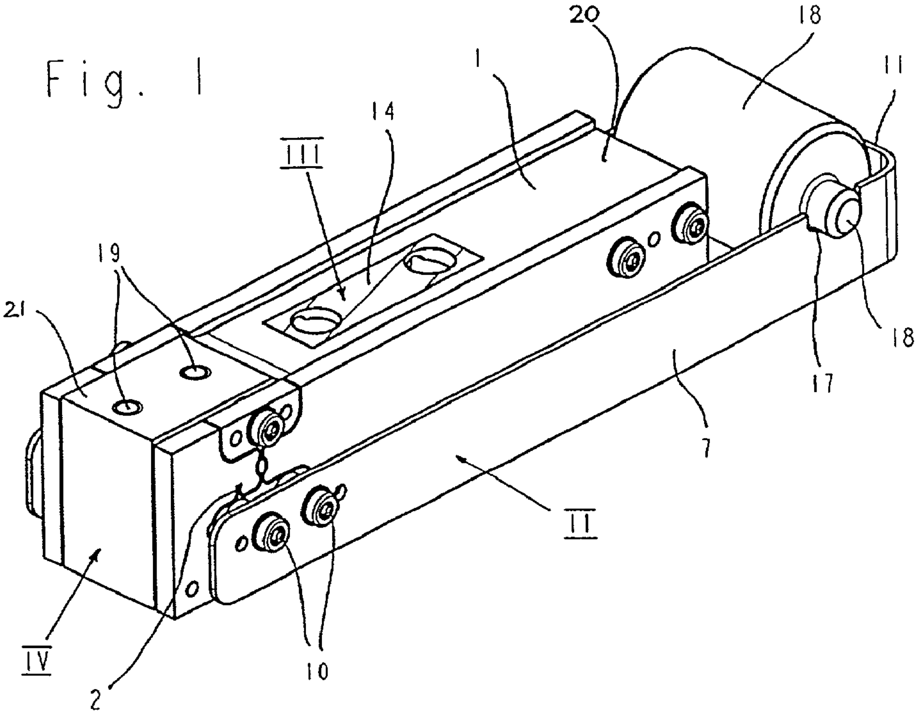


Fig. 1



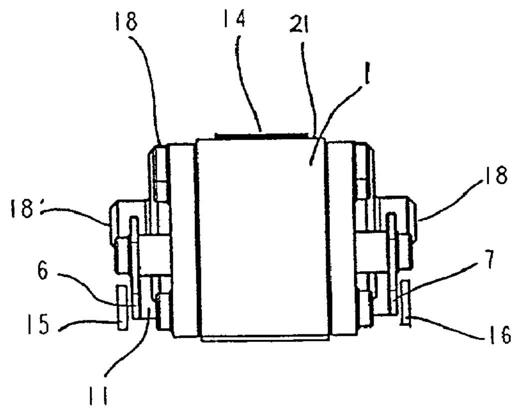


Fig. 4

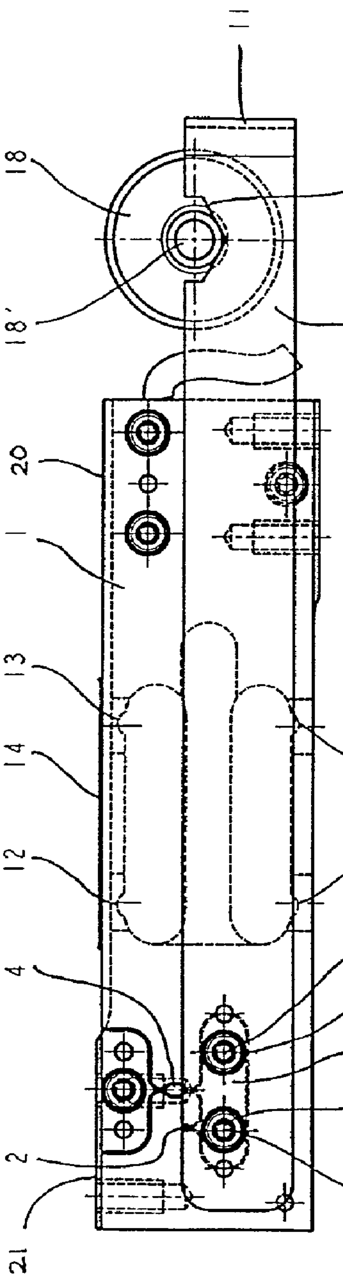

11
18
17
18'
7
20
1
13
14
12
4
9
10
5
8
2
21

Fig. 2

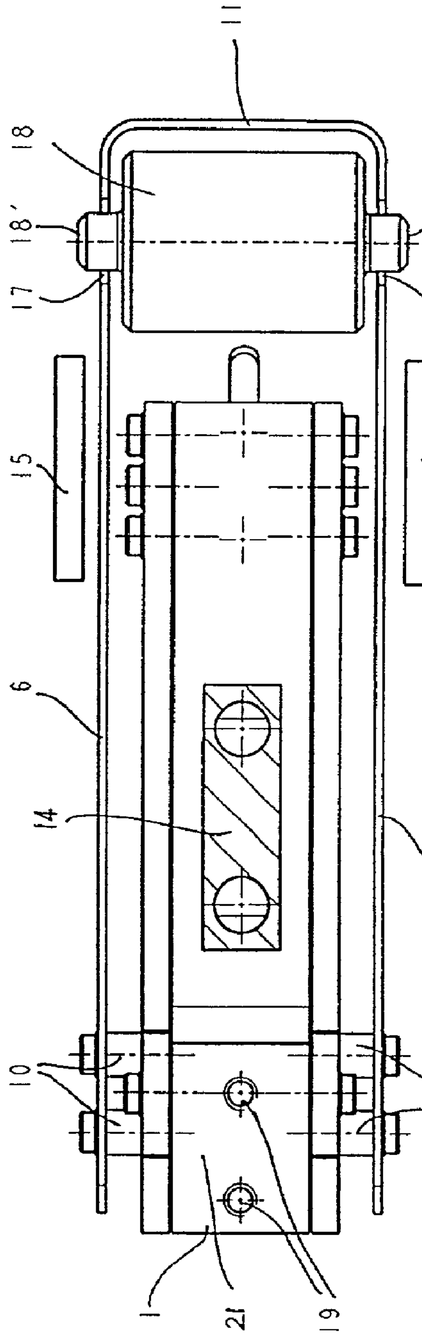
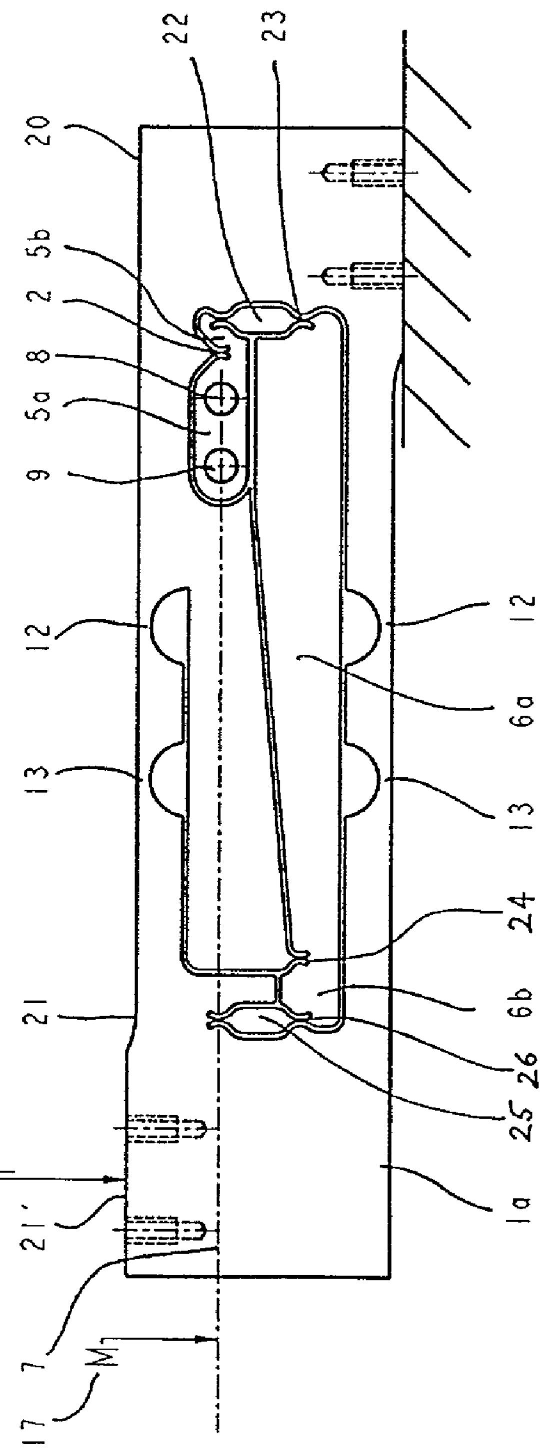

11
18
18'
17
15
16
6
14
7
10
1
21
19

Fig. 3

Fig. 5



CALIBRATION SYSTEM FOR A WEIGHING SCALE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a lever system for a weighing scale that has an electrical and/or optical force transducer generating signals corresponding to the weight of an object that has been placed on the scale. The force transducer is attached to a material body that is coupled to the lever system, and the lever system includes a receiving means for a calibration weight. The function of the force transducer is generally performed by a strain gauge, although in principle it would also be possible to use piezoelectric or other known devices. As an optical transducer, one might consider an interferometer of an essentially known type, e.g., a Michelson interferometer.

[0002] Lever systems of this kind are installed in weighing scales. At least at the conclusion of the manufacturing process, the scales are calibrated, and in most cases, the calibration is renewed within certain time intervals. Although the lever system has a receiving means for a calibration weight, the receiving means generally consists of the weighing pan or, in a wider sense, of the receiving means for the objects themselves that are to be weighed. This means that in some cases very heavy calibration weights have to be put on the scale or, also, that it is hardly practical to couple a calibration weight of a large mass directly to the lever system, given that the latter is generally configured as a separate built-in module. Additional difficulties arise if one attempts to effectively damp the oscillations occurring in a lever system of this type.

SUMMARY OF THE INVENTION

[0003] It is therefore the object of the present invention to provide improvements in the way lever systems of the type described above are calibrated and/or damped. According to the invention, this is accomplished by arranging the receiving means for the calibration weight on a magnifying lever, so that the force exerted by the calibration weight and/or the damper element is magnified. At least a portion of the inventive lever system, in some cases the entire system, is formed out of an integral material block.

[0004] Scales of the type described at the beginning are especially well suited for large weighing capacities, i.e., they are the kind of scales in which the calibration process according to the prior art is particularly difficult. However, by using a magnifying lever in an arrangement where the calibration weight and/or the force of a damper element is magnified by lever action, it is possible to use a much smaller calibration weight. As a result, lever systems and weighing scales of the kind described above can be easily calibrated and also very effectively damped by using the inventive arrangement.

[0005] Basically, two ways are conceivable in which the invention may be advantageously realized. The first way is to configure the magnifying lever together with at least a portion of the lever system, or in certain cases the entire lever system, as a lever that is cut out of and pivotally connected within an integral block, whereby the manufacture of the lever system is simplified and a more compact construction is achieved. The second way is to configure the magnifying lever as a separate lever that is attached to and extends beyond the contours of the integral block, so that the integral block itself can be relatively compact and lightweight while still allowing a large lever magnification to be achieved.

[0006] In either case, if an integral block is used, it is advantageous if the electrical force transducer is attached to the block rather than to a separate lever system or transmission member.

[0007] It is self-evident that lever systems of this kind in principle represent spring/mass systems and therefore have a tendency to oscillate. The invention can be very advantageously applied to alleviate this problem by means of an inductive damper element that cooperates with the (metallic) magnifying lever. In particular, the damper element comprises a permanent magnet in an arrangement where oscillation-damping eddy currents are generated in the lever.

[0008] It has been found that excellent results are obtained with an embodiment where the inductive damper element is arranged laterally alongside the lengthwise extension of the magnifying lever, although one would expect the damping force to be stronger with the magnet arranged at the transverse end face of the lever. Yet, according to the invention, the arrangement can be further developed and give even better results if at least two inductive elements are each arranged laterally on opposite sides of the lengthwise extension of the magnifying lever. "At least two" in this context means that the sides of a lever, especially a relatively large magnifying lever, offer ample space for more than two such damper elements. Also, a solution of this kind does not exclude the possibility of placing a third damper element, e.g., at the end face of the magnifying lever.

[0009] Further details of the invention are presented in the following description of embodiments that are illustrated schematically in the drawing.

BRIEF DESCRIPTION OF THE DRAWING

[0010] **FIG. 1** represents a perspective view of a lever system according to the invention;

[0011] **FIG. 2** represents a side view in the direction indicated by the arrow II of **FIG. 1**;

[0012] **FIG. 3** represents a top view in the direction indicated by the arrow III of **FIG. 1**;

[0013] **FIG. 4** represents an end view in the direction indicated by the arrow IV of **FIG. 1**; and

[0014] **FIG. 5** represents a side view of a particularly preferred embodiment seen from the same direction as the embodiment in **FIG. 2**.

DETAILED DESCRIPTION OF THE INVENTION

[0015] According to the **FIGS. 1 through 4**, a lever system for a weighing scale comprises a block **1**, preferably of monolithic configuration, of the kind that has become known in the field of weighing scales for example from the European patent EP-B-0 612 985. The configuration of a block like the block **1** can be seen in an exemplary way in said European patent, whose content is hereby included by reference as part of the present disclosure. Only as a brief summary, the subject of that patent is a lever system with lever arms that are cut out of a block by spark erosion and are pivotally connected by thin material portions. The levers themselves can be arranged in any manner to suit a given purpose.

[0016] It is evident that a block **1** of this kind generally has to be larger than the largest lever contained within it. Thus, for longer levers, the block will be relatively long and correspondingly heavy. To some degree, this puts a practical limit on the lever length. Now, in order to nevertheless achieve a particularly large lever magnification, an arrangement is provided in which a lever **5**, rotatable about a thinned-down, elastically flexible fulcrum portion **2** (**FIG. 1, 2**), is connected to a second lever **7** through a coupling member **4**. Two long lever arms **6, 7** are attached to the lever **5** outside of the block **1** by means of fastener pins **10** passing through attachment holes **8, 9**. As can be seen in FIGS. **1** to **3**, the lever arms **6, 7** (connected at the end by a U-turn segment **11**) extend considerably beyond the length of the block **1** without significantly increasing the total weight. Now, when a force is applied to the magnifying lever **6, 7**, it will be transmitted in a very effective way to the lever system of the block **1** and thus in the end to an electrical force transducer in the form of at least one strain gauge **14** (shown only schematically in **FIG. 1**) at the top (and/or bottom) side of two flexure domains **12, 13** (**FIG. 2**) of block **1**.

[0017] As shown with particular clarity in **FIG. 3**, permanent magnets **15, 16** are located preferably opposite the sides and as close as possible towards the end of the lever arms **6, 7**, so that any movement of the lever arms **6, 7** is damped by eddy currents that are generated inside the metallic lever arms **6, 7**. Of course, the arrangement shown here represents only one possibility among many, although it has proven to be particularly advantageous. For example, permanent magnets of this kind may be provided not only on the outside of the arms **6, 7** but also at the opposite inside locations. Furthermore, more than one magnet may be arranged in a row along the arms **6, 7**, although the placement near the free ends clearly produces the greatest damping force. Finally, it is also conceivable to arrange a damper magnet in the area of the transverse U-turn segment **11**.

[0018] As is further evident from the drawing, the free end of the lever arms **6, 7** comprises a receiving means **17** for a calibration weight **18**. The arrangement of the receiving means **17**, as shown most clearly in **FIGS. 2 and 3**, consists of cutouts that are located opposite each other on the lever arms **6, 7**. To define the seating position of the calibration weight **18**, it is advantageous if the cutouts are at least in part V-shaped as indicated in **FIG. 2** to receive the cylindrical axle **18'** of the calibration weight **18**. Clearly, this represents a particularly advantageous embodiment in comparison to other possible solutions, such as a triangular or prismatic axle **18'** that could be received in a correspondingly shaped cutout. The receiving means **17** could also be formed by projections on the lever arms **6, 7**, but this is less preferred from a manufacturing point of view. Nevertheless, using any one of these possible solutions, the weight that is used for the calibration can be made significantly lighter and easier to handle.

[0019] The advantage of the lever-magnified calibration weight is achieved by attaching the weighing pan (not shown in FIGS. **1** to **4**) to the same area of the block **1** where the lever system introduces the force of the calibration weight into the block **1**, i.e., the load-receiving area **21**. The holes **19** are provided for the attachment of the weighing pan. The lever ratios within the block **1** in relation to the lever arm distance of the receiving means **17** for the calibration weight have to be appropriately adapted, so that the calibration weight generates the correct amount of load on the block **1**. The stationary side **20** is located at the opposite end of the block **1**.

[0020] **FIG. 5** represents a further embodiment of a block la. In the following description of this embodiment, parts that perform the same function as in the previously discussed figures are identified by the same reference numbers, and parts that perform a merely similar function are identified by the same reference numbers with the addition of a letter. Thus, the description of the respective elements need not be repeated in detail.

[0021] In the embodiment of a block la that is shown in **FIG. 5**, the magnifying lever **7** is shown only schematically. As in the preceding example, the lever **7** is attached to the lever **5*a*** by means of pins (see ref. **10** in the preceding figures) engaged in attachment holes **8, 9**, and the lever **5*a*** is rotatable about a thinned-down, elastically flexible fulcrum portion **2**. The lever **5*a*** is a two-armed lever with a relatively short lever arm **5*b*** extending to the right of the fulcrum **2**, so that the calibration weight M placed on the magnifying lever **7** at the location **17** is magnified at the ratio of the lever arms **7** and **5*b*** and introduced into a coupling member **22**. The coupling member **22** is connected through a flexible pivot portion **23** to the end of a relatively long lever arm **6*a*** that is rotatable about a further spatially fixed fulcrum portion **24**. The lever arm **6*a*** also belongs to a two-armed lever that has a second, shorter arm **6*b***. As a result, the calibration weight placed at location **17** is magnified a second time.

[0022] Not the least of the factors to be considered, the lever ratio represents the relationship between the calibration weight and an equivalent weighing load placed on the scale. The load-receiving area in **FIG. 5** is again identified as **21**, more specifically **21'**. The weighing load F is applied to the area **21'** and introduced at **21** through a coupling member **25** and subsequently through a flexing pivot **26** into the lever arm **6*b***. Here, too, the locations **12** and **13** represent flexural domains for mounting a strain gauge (not shown in **FIG. 5**; see ref. **14** in FIGS. **1-4**). It is also self-evident that damper magnets can again be arranged to cooperate with the magnifying lever **7** in the same advantageous manner as the magnets **15, 16** in the preceding figures.

[0023] Numerous variations are possible within the scope of the invention. For example, the lever **7**, too, could in principle be a part of the block **1**, but this would make the block too large and heavy, which is why the illustrated embodiment with a separate lever **7** attached to the block **1** is preferable. Theoretically, the damper elements could also be electromagnets instead of the permanent magnets **5, 6** shown, although this appears to be less practical.

What is claimed is:

1. A lever system for a weighing scale with a measuring transducer producing signals in response to a weight of an object placed on the weighing scale, the measuring transducer being attached to a body that is coupled to the lever system and the lever system having a means for receiving a calibration weight, wherein the improvement comprises

a magnifying lever on which the means for receiving the calibration weight is arranged so that the force exerted by the calibration weight is magnified before it is introduced into the body that holds the force transducer,

the additional distinctive feature that at least a part of the lever system is formed of an integral block.

2. The lever system according to claim 1, comprising at least one damper element exerting a damping on the magnifying lever, arranged so that the damping force is magnified by the magnifying lever.

3. The lever system according to claim 1, wherein the magnifying lever is connected to the integral block and extends lengthwise beyond the integral block.

4. The lever system according to claim 1, wherein the measuring transducer is attached to the integral block.

5. The lever system according to claim 1, comprising within the integral block a further magnifying lever arrangement for the calibration weight.

6. The lever system according to claim 2, wherein the magnifying lever consists of metal and the at least one damper element comprises an inductive damper element in the form of a permanent magnet arranged to generate eddy currents in the magnifying lever and thereby damp oscillations.

7. The lever system according to claim 6, wherein the inductive damper element is arranged laterally alongside the lengthwise extension of the magnifying lever.

8. The lever system according to claim 7, wherein at least two inductive damper elements are each arranged laterally on a respective side of the lengthwise extension of the magnifying lever.

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