Wobble-free Furniture

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Figures

Figure 1: Stability region of a three-legged table (shaded)
Weights have more effect the further they get from the shaded region.

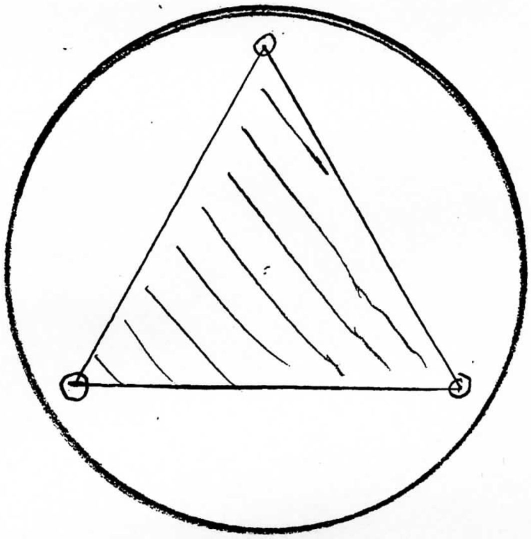
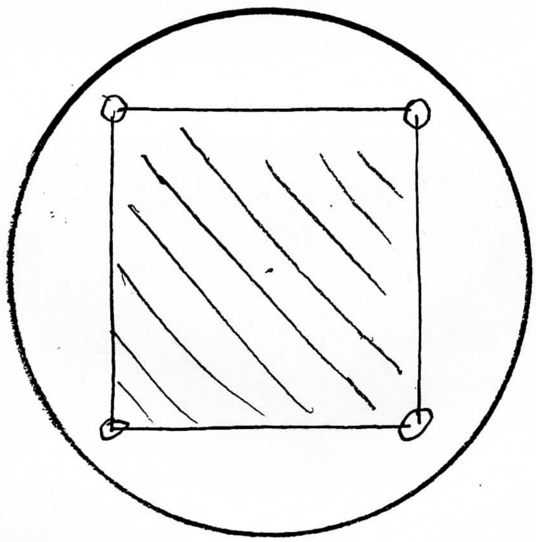


Figure 2: Stability region of a four-legged table (shaded)
Weights have more effect the further they get from the shaded region.



Signed: ______________________________ Date: ____________

Read and Understood by:

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Figure 3: The virtual support point "E"

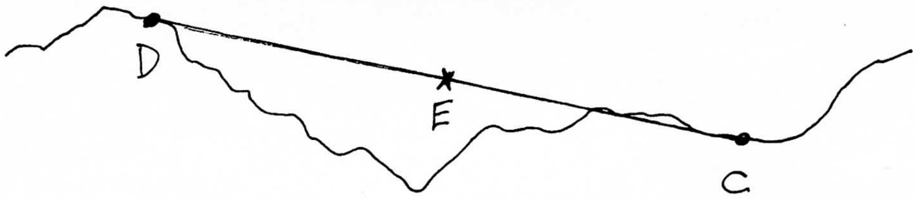


Figure 4: A four-legged table with a center post

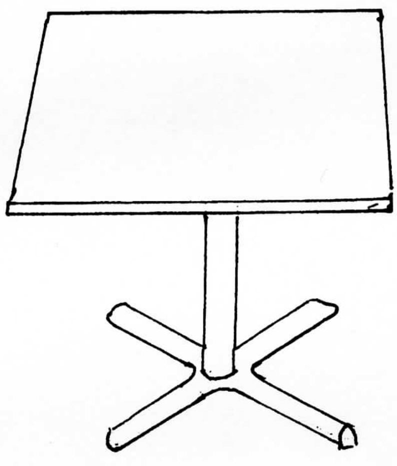


Figure 5: A pivoting anti-wobble mechanism

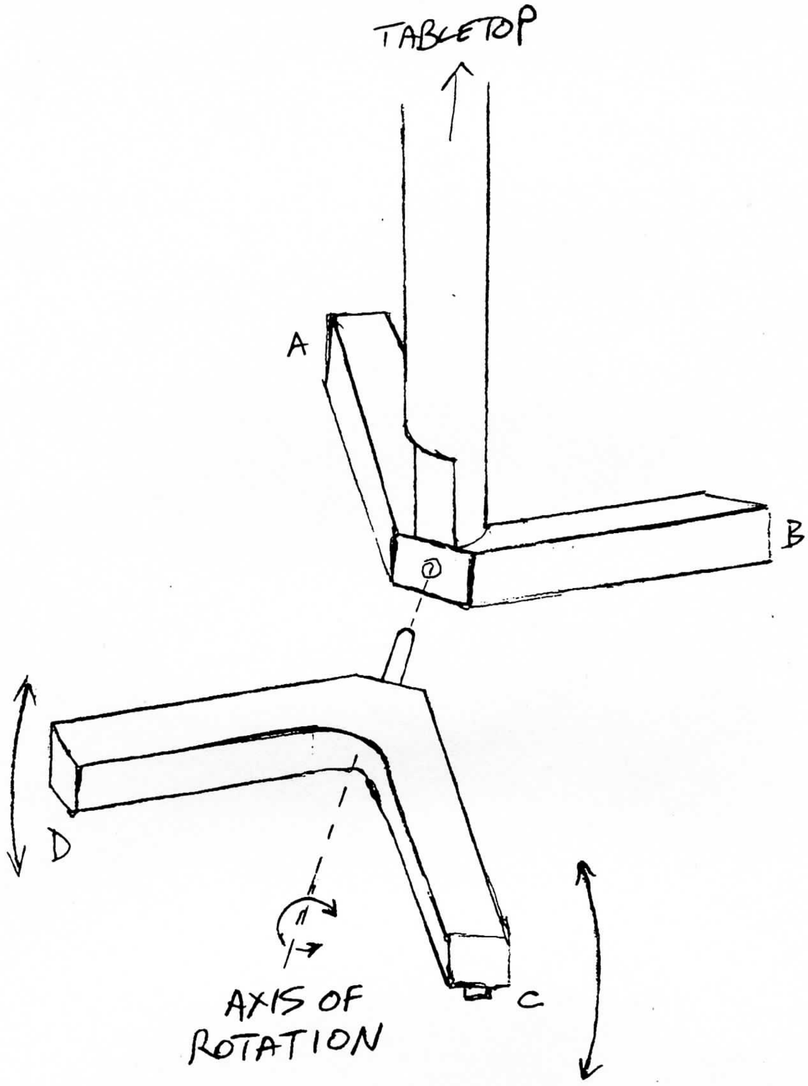


Figure 6: A top-pivoting implementation with a parallelogram linkage

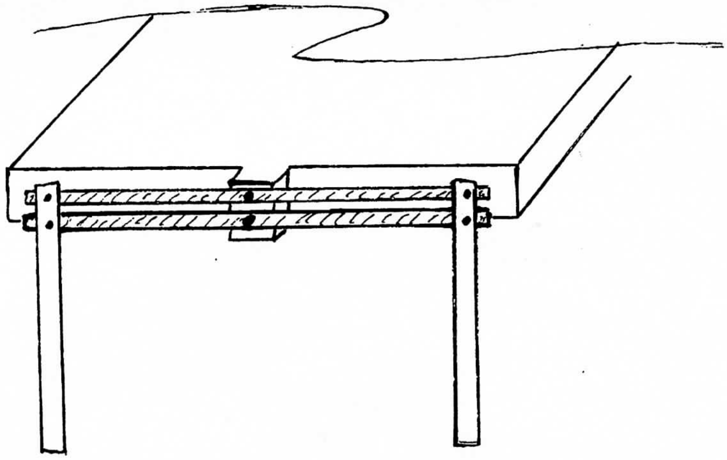


Figure 7: The bellows implementation

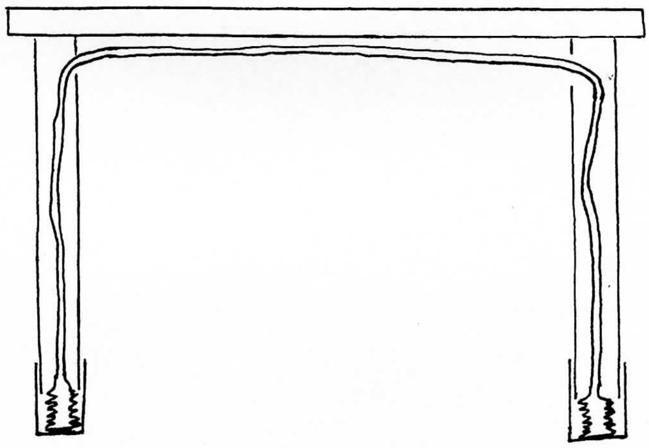
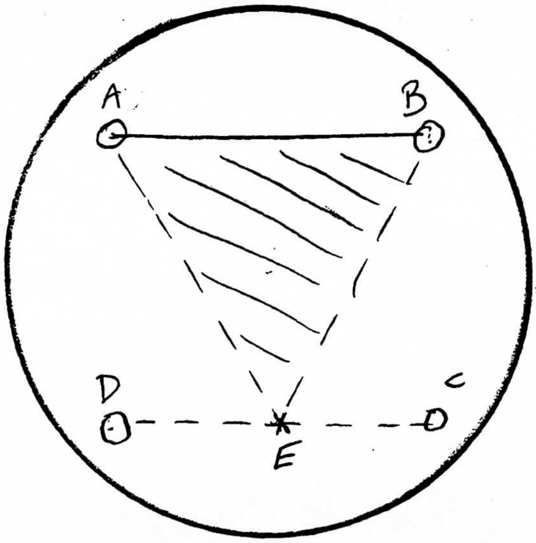


Figure 8: The stability region (shaded) without a limit on motion



End of figures

Discussion:

Virtually everyone has had the annoying experience of trying to eat a meal at a table, or work at a desk, or sit on a chair, that rocks back and forth on its legs. This is usually the result of a table with four (or more) points of contact with the floor being placed on a floor that is slightly uneven. Restaurant patrons can often be seen stuffing paper napkins or packets of sugar under one of the table's feet to try to stabilize it. Although the example of a wobbling table will be used in the following discussion, the principle applies equally to a desk, a chair, or any other platform supported by legs of any length.

Some attempts to remedy this problem can be found in the prior art. Consider patent number 5,251,858, Wobble-resisting furniture, Arnoldus J. Ultee, October 12, 1993. It teaches a method whereby one of the four legs is weighted with respect to the others, and a shorter opposite leg contains a spring-loaded member automatically extending to the floor. Many other patents use variations on the approach of spring-loaded legs: 1,559,234 (Fleming), 1,798,272 (Phillips), 2,176,255 (Frost), 2,683,576 (Miller), 2,775,849 (Ingram), and 3,827,663 (Hinman).

A similar approach is sold by the company "On The Level", 1429 Holmes Road, Elgin, IL 60123 (tel: 847-888-8220). They have a web site at http://www.onthelevel.net/. They sell spring-loaded "glides" that can be installed onto the bottom of a table's legs.

There is, of course, an even simpler way to be sure a table doesn't wobble: give it only three points of support instead of four. It is fairly obvious that such a table will not wobble, to wit: consider setting it down at an angle, such that only two of the support points touch the floor. The two points of support then define a straight line, about which the table can be rotated until the third point also touches the floor. The three points define a plane, to which the table top will be parallel, assuming the legs are of equal length. If the floor is uneven, the table top may not be perfectly level, but the table will not wobble.

However, there are various reasons why a table with only three points of support is not desirable. It is more easily tipped over than a table with four points of support, since it can be tipped by a heavy weight placed anywhere vertically outside the triangle defined by where the support points touch the floor. Figure 1 illustrates this for a circular tabletop: a heavy weight placed outside the cross-hatched triangle can tip the table. With four support points, the weight would have to be placed outside the quadrilateral defined by the four contact points, which covers a greater portion of the table's area, as shown in Figure 2.

In addition, with a square or rectangular table, four supporting legs can be placed in the corners, making the sides of the table more fully useable. This is true whether the table has four separate legs, or whether the "legs" comprise four horizontal arms protruding from the base of a central post, as in the type of table shown in Figure 4.

The present invention teaches a way of constructing a table with four points of support, but with the stability of a table with only three points of support. For purposes of discussion, let's label the four points of contact with the floor A, B, C, and D, clockwise as seen from above, and starting with an arbitrary point. Two of the adjacent contact points, say A and B, are rigidly connected to the table top, in the manner of ordinary legs. The contact points C and D at the bottom of the other two supports can move a short distance vertically (towards or away from the table top). They are furthermore mechanically connected such that the sum of their distances from the table top is constant. Thus, if one of them, for example C, is pushed up towards the table top, the other one, D, will move down, away from the table top, a corresponding distance. The effect of this is to create a "virtual" point of support midway between support points C and D, like the fulcrum of a seesaw.

The effect is that supports C and D are allowed to move up and down to conform to an uneven floor. The table will act as if it were supported by three points: points A and B, and a third point, point E, midway along a line drawn between points C and D. That is, it will behave as if it had three legs, and hence will be stable even on an uneven floor. This is illustrated in Figure 3, with the unevenness of the floor grossly exaggerated. The table will act as if it has three points of support: the "real" support points A and B, and the "virtual" support point E (midway between C and D). Note that point E is not necessarily on the floor. The height of virtual support point E is the average of the heights of points C and D, so it may be either above or below the actual height of the floor at that point.

To be more general: the invention will work even if when point C goes up, the amount point D goes down is not exactly equal. The effect is just to shift the virtual support point E so as to not be equidistant between C and D. Most implementations will want to place point E in the middle, but the patent should not be evaded simply by not making the vertical motion of points C and D exactly equal and opposite.

The linking of C and D can be done by a variety of very simple mechanical methods. Perhaps the simplest is to just pivot these points along an axis which is a perpendicular bisector of a line between C and D. Consider a table of the type shown in Figure 4, with a central vertical support post from which four horizontal legs protrude out near the floor. Figure 5 shows the bottom of the leg assembly (tabletop removed for clarity), with the anti-wobble mechanism added. The central vertical support post is rigidly connected only to legs A and B. Legs C and D are rigidly connected to each other, but are connected to the A/B/Support Post assembly by a pivot mechanism, allowing legs C and D together to pivot around the axis shown as a dotted line. Obviously, if support point C is pushed up, the pivot will rotate, pushing support point D down the same amount. C and D will function together to produce a "virtual" support point midway between them, lying on the axis of rotation about the pivot.

The use of this mechanism is not restricted to tables with a vertical central support post. It can be used with tables with four separate legs, by moving the pivot upward to just below the tabletop. If desired, a parallelogram linkage could be used to keep the pivoting legs vertical, as shown in Figure 6. In the case of a desk, such as a school desk, it would be best to put the two fixed legs on the side towards the user for maximum stability, since the user of a desk is apt to rest his or her elbows on the desk. A heavy downward force is less likely to be placed on the opposite edge of the desk, away from the user, outside the stability triangle.

Other means of obtaining the desired linked motion of points C and D will occur to those skilled in the art, such as a bicycle brake cable linkage, or two piston/cylinder pairs or bellows connected with a fluid-filled tube. Figure 7 shows two fluid-filled bellows connected by a thin tube on legs C and D of a four-legged table (the fluid needs to be incompressible; for example, water). One advantage of the bellows implementation is that it automatically provides damping (a "dashpot" effect), simply by using a thin connecting tube. Another advantage is that it automatically provides a limited range of motion, by virtue of its maximum extension. The desirability of damping and a limited range of motion are discussed below. The piston or bellows implementation can also be used as feet on a table with a central post, and in fact might turn out to be the preferred implementation, based on manufacturing cost.

As described so far, although the table has four legs, it is mechanically equivalent to a table with three legs having three support points, A, B, and the virtual support point E. As such, it has the same tipping problem of any three-legged table: it can be tipped by a heavy weight outside the triangle A-B-E, as shown in Figure 8. But this problem can be easily solved by not allowing an unrestricted motion of supports C and D. If they can only move vertically a short distance, they will be able to accommodate the average uneven floor, while still providing the anti-tipping effect of a four-legged table.

Another desirable addition to the design is to add the equivalent of a dashpot to slow the motion of points C and D. A dashpot provides a force countering any motion that is proportional to the velocity of the motion. Thus, it freely allows slow movement, but resists rapid movement. The result will be that the table will settle in to compensate for any unevenness of the floor, but will not react rapidly to forces outside the stability triangle (even though in any case, it wouldn't go far before hitting the limit). A "dashpot" can be as simple as a viscous grease in the pivot, or narrow tubes between the fluid-filled bellows.

Note again that although the above discussion has used tables as an example, this invention is not restricted to use in tables. It can be used to stabilize any four-legged object on an uneven surface, including but not limited to desks, chairs and other furniture. For that matter, it can be generalized to objects supported by more than four legs. That is done with two fixed legs, and mechanical connections among all the other legs such that the sum of their lengths is fixed. In this case, the use of multiple fluid-filled piston/cylinder pairs or bellows interconnected by tubing is particularly appealing, since the desired mechanical constraint would follow from the total volume of enclosed fluid in the totality of the system being constant.

What is claimed is:

1. An apparatus supporting an object to be set down on a surface, comprising two fixed support points, and two or more additional support points which are interconnected mechanically such that when one is moved towards the supported object, the others moves away from the supported object.

2. An apparatus as claimed in claim 1 and in which the sum of the distances of the interconnected moving supports from the supported object is fixed.

3. An apparatus as claimed in claim 1 and in which some form of damping provides greater resistance to motion of the moving support points at higher velocities of motion, and low resistance at low speeds of motion.

4. An apparatus as claimed in claim 1 and in which the range of motion of the moving support points is limited.

5. An apparatus as claimed in claim 1 and in which there are only two additional support points, interconnected by being pivoted around a third point, such that when one is moved towards the supported object, the other moves away from the supported object.

6. An apparatus as claimed in claim 5 and in which the pivot point is equidistant between the two interconnected moving support points, such that the sum of their distances from the supported object is fixed.

7. An apparatus as claimed in claim 1 and in which the sum of the distances of the moving support points from the supported object is fixed by means of connecting these support points to the supported object through bellows or piston/cylinder pairs or some such equivalent means, with an incompressible fluid contained therein being interconnected via narrow tubing.

(Corresponding "method" claims)