

Description

It sometimes happens that electrical conductors must be routed between rotatable portions of an apparatus. For example, in one small folding pocket calculator, that when closed is about 0,064 mm (one quarter of an inch) thick and approximately the length and width of a credit card, the two sections that fold are joined by a hinge. One section carries the display, while the other carries the keyboard and processing means. In such a calculator it is necessary to connect the display to the processing means with several conductors that traverse the hinge. One solution is to simply route the conductors of a flexible printed circuit along the inside surface of the hinge and at right angles to the axis of hinge rotation. The hinge itself may be a strip or flap of flexible material (e.g., cloth), and may allow nearly three hundred and sixty degrees rotation. With such a solution the radius of the hinging action also essentially determines the bending radius of the conductors. It is frequently desired that the radius of the hinge be small, as any increase in that radius adds to the size of the apparatus. However, as the radius decreases there is an increase in the bending stress incurred by the conductors. Each cycle of rotation applies compression and tension to the conductors. A clear concern in such instances arises for the ability of the conductors to resist breakage after some number of cycles of rotation. A second concern is how to protect the conductors from accidental injury, since in the absence of such protection they are exposed whenever the calculator is opened for use. A common solution in these cases is to simply cover the conductors with a flap of flexible protective material, such as vinyl or cloth. Such a measure is less than foolproof, since the protective flap is itself susceptible to injury, and may be cut or punctured by sharp objects.

As another example, the Hewlett-Packard Model 110 portable computer has a non-articulated hinged display section that rotates about a single axis, so that the display may be unlatched and made visible by rotating it away from the main portion of the computer. The conductors connecting the display section with the main portion of the computer are routed along the axis of rotation in the main portion before entering a hollow hinge. The hinge is formed from two fixed arms that extend from the display section and that rotate about respective distal captive annular sections. The conductors are individual insulated wires in a bundle anchored in a first location by a first strain relief at the point where the bundle enters one of the annular sections of the hinge. Thereafter, the bundle remains fixed in relation to the display as they both rotate together relative to the main body

of the computer. Along the bundle in the other direction (i.e., from the strain relief in the display section back toward the main portion of the computer) there is a second strain relief anchoring to the main portion of the computer a second location of that part of the bundle running along the axis of the hinge. At the second location the bundle remains fixed in relation to the main body of the computer. Generally speaking, the first and second locations of strain relief are at opposite ends of that section of the bundle that runs along the axis of hinge rotation. The portion of the bundle between the two strain reliefs thus experiences distributed torsional stress during the rotational excursions of the display section. Such distributed torsional stress is superior to the locally concentrated stresses of compression and tension found in conventional bending. Unfortunately, the hinge and torsional method just described may not be applicable where the amount of rotation desired approaches one complete revolution. Another example of a handheld calculator according to the preamble of claim 1 and 4 is disclosed in US-A-4 369 489.

It would be desirable if a pocket calculator or other device could enjoy the benefits of torsional flexing of the conductors connecting rotating parts in an application where the parts were capable of rotating through a complete revolution.

Torsional flexing of conductors, as well as other objects of the invention, are realized in a design that incorporates a hollow intervening member serving as an articulated hinge between the two parts or assemblies to be interconnected. The term "articulated hinge" means that there are two separate and parallel axes of rotation; a first axis between the intervening member and the casing of a first assembly, and a second axis between the intervening member and the casing of the second assembly. The means that make the articulated hinge captive to the other assemblies does so by having preferably a hollow spindle portion of one part extend a short distance into a corresponding socket portion of another. The end of the hollow spindle portion and the floor of the socket portion each have matching holes that are in alignment, and that are centered about the axis of rotation. In this way an interior passage is formed between the first assembly and the hollow articulated hinge, and then further between the hinge and the second assembly. The result is a well protected interior passage between the first and second assemblies. Several flexible printed circuit traces are routed from one assembly to the other. Each axis of rotation of the articulated hinge is limited to a total displacement of approximately one hundred and eighty to two hundred degrees. The two assemblies can thus move through one complete revolu-

tion relative to one another.

Preferably the traces of the flexible printed circuits are strain relieved at four places: once upon leaving each assembly to enter the articulated hinge along the associated axis, and twice approximately in the center of the articulated hinge (once on either side of where the flexible printed circuits transition from one axis to the other). The strain relief limits the amount of torsion the flexible printed circuit traces experience at any one place, and apportions the torsion to two separate portions of those traces in accordance with how each assembly is rotated relative to the articulated hinge.

A further object realized by the above-described invention is that of protecting the conductors from damage. This result obtains because the conductors remain fully encased as they go from one assembly to the other.

Still other objects are realized by the invention when the first and second assemblies comprise the top and bottom case halves of a small handheld calculator. These include an easy way to locate keypads on both halves of the case, and the related object of allowing the use of one flexible membrane keyboard assembly to interconnect the two keypads and the processing means.

Figure 1 is a top view of a handheld calculator having two keypads connected by torsionally flexed conductors routed through an articulated hinge.

Figures 2A-2E are various end views of the calculator of Figure 1, illustrating the operation of the articulated hinge.

Figure 3 is a sectional view of a portion of Figure 1, showing details of the articulated hinge.

Figure 4 is a top view of a flexible membrane keyboard assembly used in the calculator of Figure 1, and having a U-shaped section for transiting the articulated hinge of the calculator of Figure 1.

Figure 5 is a sectional view of Figure 2B illustrating in detail how the U-shaped portion of the flexible membrane keyboard assembly of Figure 4 transits the articulated hinge.

Figure 6 is a sectional view of Figure 2B similar to that of Figure 5, except that the flexible conductors of the membrane keyboard assembly exhibit an abrupt jog instead of a U-shaped turn.

Figure 7 is another sectional view of Figure 2B showing yet another alternate possibility for routing the conductors through the articulated hinge.

Figure 8 is an exploded perspective view of a portion of the two case halves and articulated hinge of the calculator of Figure 1, illustrating certain construction details.

Figure 1 shows a handheld calculator 1, which calculator 1 has a folding case that includes two case halves 2 and 3. Upon each case half 2 and 3 is located a respective keypad 4 and 5. The two keypads 4 and 5 are electrically connected to a

processing means (not shown) which responds to keystrokes and presents information upon a display 6. One problem, then, is the establishment of electrical connections between the two keypads 4 and 5, so that they appear to the processing means as a single keypad. A more general statement of the problem is how to electrically connect something located in one half of the case to something in the other half of the case. This is accomplished by the flexible membrane keyboard assembly 16 shown in Figure 4, in conjunction with the hollow articulated hinge 7 in Figure 1.

As stated earlier, what is meant by the term "articulated hinge" is a hinge having two separate and parallel axes of rotation. Figure 2 shows what types of motion between the two case halves 2 and 3 the articulated hinge 7 affords. Figure 2A shows an end view of the calculator 1 with the case halves 2 and 3 in their closed positions. Figure 2B illustrates the normal fully open position that would be used if the calculator were laid upon a flat surface. Figures 2C and 2D illustrate other fully open positions that are obtainable through the action of the articulated hinge. Figure 2E shows how the calculator 1 may be opened for use by rotating case half 3 one full revolution. This conveniently allows the calculator to be held in one hand while the other is used to actuate the keys upon the keypad 4. Keypad 4 contains most of the keys used to perform simple calculations.

Figure 3 further illustrates certain details of the articulated hinge 7. Figure 3 is a sectional view of a portion of Figure 1. Articulated hinge 7 is a generally hollow member of (in the present embodiment) oval cross section and length sufficient to prevent undue twisting that would cause the two axes of rotation 14 and 15 to not lie in the same plane.

For the sake of illustration, two different ways of joining the hinged elements are shown. In the case of axis 14, circle 8 represents a hole (socket) in case half 2 into which a raised annular projection (spindle) from member 7 protrudes, as indicated by circles 10 and 12. Additionally, circle 12 indicates a passage from the interior of case half 2 into the interior of articulated hinge member 7.

The circumstances for hinging about axis 15 are somewhat different. There, a raised annular projection (spindle) from case half 3 protrudes into a hole 9 (socket) in the member 7. Circles 11 and 13 denote the raised annular projection. Hole 13 also indicates a passage from within the case half 3 into the articulated hinge member 7. It will be understood from a general understanding of Figures 1, 3, and 8 that the same situation as depicted in Figure 3 obtains at the other end of the articulated hinge member 7. That is, a conductor could enter member 7 from case half 2 through hole 12

and then enter case half 3 through either hole 13 or its counterpart (not shown) at the other end of member 7. It will also be understood that any desirable combination of parts protruding into other parts may be used to make the case halves 2 and 3 captive to the articulated hinge member 7.

We now turn to another property of the articulated hinge 7 shown in Figure 3: rotational constraint. It is clear from Figures 1-3 that, even in the absence of any other mechanism, interference between case halves 2 and 3 will act to place some limits on the relative rotation of members 2, 3, and 7 about each other. Although the mechanism for it is not expressly shown in the drawing (which is complicated enough already) it may be desirable to equip the articulated hinge 7 with some type of stops. These could be interfering bosses or lugs, or lugs traveling in grooves of limited extent. Any convenient way may be used to limit the hinge's extent of rotation, so long as it does not interfere with the principal action of the hinge, which includes the passage of conductors through a hole centered upon the axis of rotation.

As shown in Figure 3, articulated hinge member 7 is rotated about axis 14 approximately forty-five degrees clockwise with respect to a center position that would align it with case half 2. In such an aligned state lines A and B would coincide. In like fashion, case half 3 is depicted as rotated approximately seventy degrees counter-clockwise about axis 15, relative to a center position that would align it with articulated hinge member 7. If the case half 3 were aligned with member 7 then lines C and D would coincide. The rotational stop mechanisms mentioned in the previous paragraph would operate to produce the following results. Line B, representing a point on the articulated hinge member 7, would be constrained to rotate between the extent delimited by lines E and F, which represent points upon the surface of the case half 2. Similarly for the hinge about axis 15, line D would be constrained by lines G and H. It will be understood that the limits described here are approximate, and need not be the exact one hundred and eighty degrees suggested by Figure 3. What is important is that limits are provided if they do not otherwise obtain through the natural interference of the parts being hinged, or if that natural interference is otherwise undesirable or counter-productive (say, it causes chipped paint, or perhaps pinched fingers). In the calculator 1 of Figure 1 such additional constraint is provided by the hinge, and the angle of displacement from F to E and G to H is approximately one hundred and ninety degrees.

The case halves 2 and 3 and the articulated hinge 7 may be constructed of any suitable material. For the calculator 1 these parts are made of molded polycarbonate, which is light in weight but

still strong enough to provide adequate rigidity.

Refer now to Figure 4, wherein is shown a top view of a multi-layer flexible membrane keyboard assembly 16 comprising two halves 17 and 18 joined by a U-shaped section 19. Because it is multi-layer, many more than the three conductors shown in the U-shaped section actually pass between the two halves 17 and 18.

Circles 58 represent compressible dome sections that are in mechanical contact with the keys of the keyboards. They serve to provide an "overcenter" sudden collapse when the keys are pressed, providing useful tactile feedback to the user of the calculator 1. They also provide the spring-like force that returns a pressed key to its normal position. Underneath each dome 58 is a region where two conductors are normally in close proximity to each other, but do not touch. When the dome 58 is collapsed the two conductors are brought into ohmic contact.

Flexible membrane keyboard assembly 16 is fabricated by silk screening traces of a silver paste onto sheets of polyester. Etched copper traces are feasible as well, although they are stiffer and fail after fewer cycles of rotation.

Tests conducted by the inventors revealed the following information, offered here for its comparative value only. Lengths of single layer multi-trace flexible conductors, such as portion 22 of Figure 4 and variously constructed as described above, were subjected to extended torsional flexing. Runs 5 cm (two inches) long of silver paste on polyester were clamped at one end and repeatedly twisted through one hundred degrees either side of their normal, unstressed positions. The traces ranged from 0.38 mm to 0.51 mm (fifteen to twenty mils) wide, and from 0.018 mm to 0.025 mm (seven tenths to one mil) thick. Testing on these samples was halted after over three million two hundred degree excursions resulted in no failures in the conductors. When similar tests were run with 0.036 mm (1.4 mil) copper on polyester, failures occurred after about one and a quarter million cycles.

In comparison, conventional bending was performed with a radius of 3.8 mm (.150 inches). Copper traces failed after several thousand cycles of plus and minus one hundred and eighty degree bending. The silver traces lasted between five and ten thousand cycles.

The reason for this difference appear to be that conventional bending subjects the traces to considerably greater stresses of compression and tension during the bending cycles. As a ribbon of conductor is curved the inside surface is compressed, while the outer surface experiences tension. We recognize that torsional stress is probably not a wholly separate phenomenon, and that one way to describe torsion is in terms of tension, compres-

sion, and shear. If a straight ribbon of material is twisted about its longitudinal axis, the material closest to the axis will experience compression, while that at the edges will experience tension. The tension arises because the spiral path now taken by the edges is longer than the straight-line path described by the edges of the untwisted material. Compression of the interior portion arises when the outer portions in tension do not elongate to relieve the tensile stress.

Nevertheless, it is fair to say that a half-turn twist applied to a ribbon that is considerably longer than it is wide produces such reductions in compression and tension, when compared to conventional bending (and especially small radius bending), that the forces of compression and tension associated with such torsion may be safely ignored. This is justified, since the resulting gradients of compression and tension are quite small, as a result of being distributed over the entire ribbon rather than being concentrated in one local area. Likewise, shear stress in a long flexible ribbon subjected to a torsional rotation of one half-turn is distributed over a wide area, and thus does not contribute to fatigue.

In a preferred embodiment, region 21 of the U-shaped portion 19 passes through hole 12 in Figure 3, while region 22 passes through hole 13. That and other possibilities are the subject of Figures 5-7, to which we now turn.

Figure 5 is a sectional view of Figure 2B, illustrating a the way to connect the two halves 17 and 18 of the flexible membrane keyboard assembly 16 of Figure 4. The view afforded by Figure 5 may be thought of as being obtained as follows. As will be described in connection with Figure 8, the articulated hinge 7 is formed of top and bottom halves meeting each other generally in the plane containing the two axes of rotation 14 and 15. In Figure 5 (and also in Figures 6 and 7) the top half of the articulated hinge 7 has been removed. In a similar fashion, case halves 2 and 3 each consist of outer case portions and interior keyboard retaining surfaces. In Figures 5-7 the keyboard retaining surfaces (and the keyboards beneath them) have also been removed.

The view shown in Figure 5 is indicative of the manner in which the calculator 1 is assembled. That is, bottom portions of the case halves 2 and 3 and of the articulated hinge 7 are brought into alignment and the flexible membrane keyboard assembly 16 registered thereon. To this end, holes 25, 26, and 27 fit over corresponding studs (not shown). Other parts are added, such as the keys themselves, and then the top portions of the case halves and hinge are attached (e.g., with an adhesive) to their corresponding bottom portions. The result of that is then the view shown in Figure 1.

In particular, Figure 5 shows the U-shaped section 19 as being located within an interior portion of the hollow articulated hinge 7. As case halves 2 and 3 rotate about articulated hinge 7 the "legs" 21 and 22 of the U-shaped section 19 undergo a twisting action (torsional flexing). This torsional flexing occurs between four locations 28-31 where the flexible membrane keyboard assembly 16 is strain relieved, or made captive, by lightly pinching it between interior ribs (not shown). Such strain relief at locations 28-31 does two things. First, it limits the amount of torsional flexing of any one leg to the amount of rotation experienced by the corresponding axis of rotation. Second, under conditions of maximum rotation of the case halves 2 and 3, it ensures that the overall torsional flexing experienced by the U-shaped section 19 is divided equally between legs 21 and 22.

Figure 6 illustrates an alternate embodiment similar to that shown in Figure 5. The difference is that, instead of relying upon a U-shaped bend to go from being aligned with one axis of rotation to the other, interconnecting portion 39 instead uses a jog 34. As before, holes 32 and 33 serve to register the flexible membrane keyboard assembly 16 over alignment studs (not shown) in the case and hinge parts. Reference numerals 35-38 denote locations where strain relief is provided. The torsional flexing occurs in leg portions 40 and 41.

In the embodiments of both Figure 5 and Figure 6 the leg portions 21, 22, 40, and 41 are essentially centered along the axes of hinge rotation 14 and 15. By virtue of that and of there being a strain relief at each end of legs 21, 22, 40, and 41, the interconnecting portions 19 and 39 each experience only torsional flexing and no conventional bending. In particular, note that the U-shaped bend itself, between strain relief locations 29 and 30, and the jog 34 between locations 36 and 37, each remain free of any bending whatsoever. The absence of the pronounced compression and tension induced by conventional bending greatly prolongs the life of the conductors routed through the hinge.

Figure 7 illustrates another possible embodiment. In Figure 7 the interconnecting portion 42 of the flexible membrane keyboard assembly 16 is simply a straight run from one case half to the other. It does not run parallel to either axis of hinge rotation. Accordingly, it will experience some slight amount of conventional bending at the locations of strain relief 43, 44, and 45. At location 45 the strain relief is a "slip fit", allowing the interconnecting portion 42 to slide back and forth in the direction of the double-headed arrow 46, but preventing motion in any other direction.

Figure 8 illustrates certain details of construction for the calculator 1 of Figure 1. The purpose of

the figure is to show how the various parts cooperate during assembly, so that the flexible membrane keyboard assembly 16, with its U-shaped section 19 or jogged section 39, can end up inside the case halves 2 and 3 and inside the hollow articulated hinge 7.

Observe that the articulated hinge 7 comprises a lower half 47 and an upper half 48. Similarly, case half 2 comprises a lower portion 49 and an upper portion 50, while case half 3 comprises portions 51 and 52. While these portions are apart the flexible conductors 53 (which may be a portion 19 or 39 of flexible membrane keyboard assembly 16) may be registered onto parts 49, 47, and 51.

Strain relief ribs 56 and 57 of case half 2, and their counterparts in case half 3, gently pinch the flexible conductors 53. Strain relief ribs 54 and 55 perform the same functions in the articulated hinge assembly 7.

Claims

1. A handheld calculator (1) or the like having a first case portion (2),
a display (6) mounted in the first case portion,
a first keyboard (4) mounted in the first case portion,
a second case portion (3)
the first and second case portions being coupled by means of an articulated hinge (7), characterized in
that said hinge (7) is hollow,
that said hinge (7) has two separate and parallel axes of rotation and is coupled about the first axis to the first case portion (2) and about the second axis to the second case portion (3), thus allowing relative motion of one case portion about the other by one full revolution,
that a second keyboard (5) is mounted in the second case portion and
that flexible conductors (19) are passed through the hollow articulated hinge (7) for electrically interconnecting the first and second keyboards (2,3).
2. A handheld calculator as in claim 1 wherein the flexible conductor means comprises traces upon a flexible printed circuit.
3. A handheld calculator as in claim 2 wherein the first and second case portions (2,3) and the hollow articulated hinge (7) each include a strain relief means for lightly gripping the flexible conductor means and causing the flexible conductor means to undergo torsional flexing as the first and second case portions experience relative motion of one about the other.
4. A handheld calculator (1) or the like having a flexible printed circuit assembly for interconnecting first and second assemblies, one of which is rotatable relative to the other, the flexible printed circuit comprising:
a first case portion (2) for mounting to the first assembly (17);
a second case portion (3) for mounting to the second assembly (18);
an interconnecting portion having first and second parallel sections (21,22) joined to each other at their one end by a transition section (19), the parallel sections (21,22) being joined at their other end to a respective end of the first and second portions, characterized in that the first and second parallel sections (21,22) are spaced a distance apart, that the transition section (19) traverses said distance and that the first and second parallel sections (21,22) are of sufficient length and narrowness to permit the essentially unresisted twisting thereof through at least ninety degrees along the lengths thereof.
5. A flexible printed circuit assembly as in claim 4 wherein the first and second parallel sections and the transition section comprise a U-shape.
6. A flexible printed circuit assembly as in claim 4 wherein the first and second parallel sections approach each other from opposite directions and are joined by an abrupt jog formed by the transition section.
7. A flexible printed circuit assembly as in claim 4 further comprising sheets of polyester upon which have been deposited flexible conductors.
8. A flexible printed circuit assembly as in claim 7 wherein the flexible conductors are traces of etched copper.
9. A flexible printed circuit assembly as in claim 7 wherein the flexible conductors are traces of silver-bearing paste.
10. A flexible printed circuit assembly as in claim 4 further comprising resilient domes for making electrical connections in response to collapsing the domes through the application of mechanical pressure.
11. A method of routing conductors from a first assembly to a second assembly, rotatable about the first, comprising the steps of:
hinging the first and second assemblies (2,3) together with a hollow articulated hinge,

the figure is to show how the various parts cooperate during assembly, so that the flexible membrane keyboard assembly 16, with its U-shaped section 19 or jogged section 39, can end up inside the case halves 2 and 3 and inside the hollow articulated hinge 7.

Observe that the articulated hinge 7 comprises a lower half 47 and an upper half 48. Similarly, case half 2 comprises a lower portion 49 and an upper portion 50, while case half 3 comprises portions 51 and 52. While these portions are apart the flexible conductors 53 (which may be a portion 19 or 39 of flexible membrane keyboard assembly 16) may be registered onto parts 49, 47, and 51.

Strain relief ribs 56 and 57 of case half 2, and their counterparts in case half 3, gently pinch the flexible conductors 53. Strain relief ribs 54 and 55 perform the same functions in the articulated hinge assembly 7.

Claims

1. A handheld calculator (1) or the like having a first case portion (2),
a display (6) mounted in the first case portion,
a first keyboard (4) mounted in the first case portion,
a second case portion (3)
the first and second case portions being coupled by means of an articulated hinge (7), characterized in
that said hinge (7) is hollow,
that said hinge (7) has two separate and parallel axes of rotation and is coupled about the first axis to the first case portion (2) and about the second axis to the second case portion (3), thus allowing relative motion of one case portion about the other by one full revolution,
that a second keyboard (5) is mounted in the second case portion and
that flexible conductors (19) are passed through the hollow articulated hinge (7) for electrically interconnecting the first and second keyboards (2,3).
2. A handheld calculator as in claim 1 wherein the flexible conductor means comprises traces upon a flexible printed circuit.
3. A handheld calculator as in claim 2 wherein the first and second case portions (2,3) and the hollow articulated hinge (7) each include a strain relief means for lightly gripping the flexible conductor means and causing the flexible conductor means to undergo torsional flexing as the first and second case portions experience relative motion of one about the other.

4. A handheld calculator (1) or the like having a flexible printed circuit assembly for interconnecting first and second assemblies, one of which is rotatable relative to the other, the flexible printed circuit comprising:
a first case portion (2) for mounting to the first assembly (17);
a second case portion (3) for mounting to the second assembly (18);
an interconnecting portion having first and second parallel sections (21,22) joined to each other at their one end by a transition section (19), the parallel sections (21,22) being joined at their other end to a respective end of the first and second portions, characterized in that the first and second parallel sections (21,22) are spaced a distance apart, that the transition section (19) traverses said distance and that the first and second parallel sections (21,22) are of sufficient length and narrowness to permit the essentially unresisted twisting thereof through at least ninety degrees along the lengths thereof.
5. A flexible printed circuit assembly as in claim 4 wherein the first and second parallel sections and the transition section comprise a U-shape.
6. A flexible printed circuit assembly as in claim 4 wherein the first and second parallel sections approach each other from opposite directions and are joined by an abrupt jog formed by the transition section.
7. A flexible printed circuit assembly as in claim 4 further comprising sheets of polyester upon which have been deposited flexible conductors.
8. A flexible printed circuit assembly as in claim 7 wherein the flexible conductors are traces of etched copper.
9. A flexible printed circuit assembly as in claim 7 wherein the flexible conductors are traces of silver-bearing paste.
10. A flexible printed circuit assembly as in claim 4 further comprising resilient domes for making electrical connections in response to collapsing the domes through the application of mechanical pressure.
11. A method of routing conductors from a first assembly to a second assembly, rotatable about the first, comprising the steps of:
hinging the first and second assemblies (2,3) together with a hollow articulated hinge,



wherein said hinge has two parallel axes (14,15) of rotation (7),
 passing the conductors from the first assembly (2) into the hollow articulated hinge (7) through an orifice (12) in the first assembly centered about a first axis (14) of hinge rotation;
 clamping the conductors to the first assembly (2) in close proximity to where they exit therefrom into the hollow articulated hinge (7);
 routing the conductors within the hollow articulated hinge along the first axis (14) of hinge rotation;
 altering the routing of the conductors from running along the first axis to running along a second axis (15) of hinge rotation;
 routing the conductors within the hollow articulated hinge (7) along the second axis (15) of hinge rotation;
 clamping the conductors to the hollow articulated hinge (7) at the location where the routing of the conductors is altered from running along the first axis to running along the second axis;
 passing the conductors from the hollow articulated hinge (7) into the second assembly (3) through an orifice (13) therein centered about the second axis (15) of hinge rotation; and
 clamping the conductors to the second assembly in close proximity to where they enter therein from the hollow articulated hinge (7).

12. A method of routing conductors from a first assembly to a second assembly, rotatable about the first, comprising the steps of:
 hinging the first and second assemblies (2,3) together with a hollow articulated hinge, wherein said hinge has two separate and parallel axes (14,15) of rotation;
 passing the conductors from the first assembly (2) into the hollow articulated hinge through an orifice in the first assembly centered about a first axis (14) of hinge rotation;
 clamping the conductors to the first assembly in close proximity to where they exit therefrom into the hollow articulated hinge;
 routing the conductors within the hollow articulated hinge along a straight line path (45) to the orifice centered about a second axis (15) of hinge rotation;
 clamping the conductors to the hollow articulated hinge at approximately the middle of the straight line path (45) in a manner to allow a sliding movement of the conductors along said straight line path (45);
 passing the conductors from the hollow articulated hinge into the second assembly through an orifice therein centered about the second axis (15) of hinge rotation; and
 clamping the conductors to the second assembly

bly (3) in close proximity to where they enter therein from the hollow articulated hinge.

Patentansprüche

- 5 1. Handrechner (1) oder dergleichen mit einem ersten Gehäuseteil (2),
 einem Display (6) im ersten Gehäuseteil, einem ersten Tastenfeld (4) im ersten Gehäuseteil,
 10 einem zweiten Gehäuseteil (3),
 wobei die ersten und zweiten Gehäuseteile miteinander mittels eines Scharniers (7) gekuppelt sind, dadurch gekennzeichnet,
 15 daß das Scharnier (7) hohl ist,
 daß das Scharnier (7) zwei getrennte und parallele Drehachsen aufweist und mit der ersten Achse mit dem ersten Gehäuseteil (2) und mit der zweiten Achse mit dem zweiten Gehäuseteil (3) gekuppelt ist, so daß eine Relativbewegung des einen Gehäuseteiles um das andere um eine volle Umdrehung ermöglicht ist,
 20 daß ein zweites Tastenfeld (5) im zweiten Gehäuseteil angeordnet ist und
 25 daß flexible Leiter (19) durch das hohle Scharnier (7) zum elektrischen Verbinden des ersten Tastenfeldes mit dem zweiten Tastenfeld (2, 3) hindurchgeführt sind.
- 30 2. Handrechner nach Anspruch 1, bei dem die flexiblen Leiter Leiterbahnen auf einer flexiblen gedruckten Schaltung aufweisen.
- 35 3. Handrechner nach Anspruch 2, bei dem die ersten und zweiten Gehäuseteile (2, 3) und das hohle Scharnier (7) je eine Dehnungsentlastungsvorrichtung zum leichten Greifen des flexiblen Leiters und zum Veranlassen des 7gs flexiblen Leiters zu einer Torsionsverformung aufweisen, wenn die ersten und zweiten Gehäuseteile eine Relativbewegung umeinander erfahren.
- 40 4. Handrechner (1) oder dergleichen mit einer flexiblen gedruckten Schaltung zum Verbinden erster und zweiter Anordnungen, von denen eine drehbar relativ zur anderen ist, wobei die gedruckte Schaltung umfaßt:
 45 ein erstes Gehäuseteil (2) zum Anbringen an der ersten Anordnung (17);
 50 ein zweites Gehäuseteil (3) zum Anbringen an der zweiten Anordnung (18);
 einen Verbindungsabschnitt mit ersten und zweiten parallelen Sektionen (21, 22), die miteinander an ihren einen Enden über eine Übergangssektion (19) verbunden sind, wobei die parallelen Sektionen (21, 22) an ihren anderen Enden jeweils mit einem entsprechenden Ende
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- der ersten und zweiten Gehäuseabschnitte verbunden sind, dadurch **gekennzeichnet**, daß die ersten und zweiten parallelen Sektionen (21, 22) in einem Abstand voneinander angeordnet sind, daß die Übergangssektion (19) diesen Anstand überbrückt und daß die ersten und zweiten parallelen Sektionen (21, 22) ausreichende Länge und Schmalheit haben, um deren im wesentlichen widerstandloses Verwinden um mindestens 90° über ihre Länge zu erlauben.
5. Flexible gedruckte Schaltung nach Anspruch 4, bei der die ersten und zweiten parallelen Sektionen und die Übergangssektionen eine U-Form bilden.
6. Flexible gedruckte Schaltung nach Anspruch 4, bei der die ersten und zweiten parallelen Sektionen von entgegengesetzten Richtungen einander nähern und über eine abrupte, von der Übergangssektion gebildete Abknickung miteinander verbunden sind.
7. Flexible gedruckte Schaltung nach Anspruch 4, umfassend Polyester-Lagen, auf welchen die flexiblen Leiter aufgebracht sind.
8. Flexible gedruckte Schaltung nach Anspruch 7, bei der die flexiblen Leiter von Leiterbahnen aus geätztem Kupfer gebildet sind.
9. Flexible gedruckte Schaltung nach Anspruch 7, bei der die flexiblen Leiter von Leiterbahnen aus einer silbertragenden Paste gebildet sind.
10. Flexible gedruckte Schaltung nach Anspruch 4, umfassend nachgiebige Erhebungen zum Herstellen elektrischer Verbindungen auf das Kolabrieren der Erhebungen durch Ausüben von mechanischem Druck hin.
11. Verfahren zum Führen von Leitern von einer ersten Anordnung zu einer zweiten Anordnung, welche um die erste Anordnung drehbar ist, umfassend die folgenden Schritte:
Anlenken der ersten und zweiten Anordnungen (2, 3) aneinander über ein hohles Scharnier, welches zwei parallele Drehachsen (14, 15) aufweist;
Durchführen der Leiter von der ersten Anordnung (2) in das hohle Scharnier (7) über eine Öffnung (12) in der ersten Anordnung, welche um eine erste Achse (14) der Scharnierdrehung zentriert ist;
Klemmen der Leiter an die erste Anordnung (2) nächst der Stelle, wo sie daraus heraus- und in das hohle Scharnier eintreten;

Führen der Leiter in dem hohlen Scharnier längs der ersten Achse (14) der Scharnierdrehung;
Umlenken der Leiter aus der Bahn längs der ersten Achse in eine Bahn längs der zweiten Achse (15) der Scharnierdrehung;
Führen der Leiter in dem hohlen Scharnier (7) längs der zweiten Achse (15) der Scharnierdrehung;
Klemmen der Leiter an das hohle Scharnier (7) an der Stelle, wo die Umlenkung aus der Bahn längs der ersten Achse in die Bahn längs der zweiten Achse stattfindet;
Passieren der Leiter aus dem hohlen Scharnier (7) in die zweite Anordnung (3) über eine Öffnung (13), die darin um die zweite Achse (15) der Scharnierdrehung zentriert ist;
Klemmen der Leiter an die zweite Anordnung, wo sie in diese aus dem hohlen Scharnier (7) eintreten.

12. Verfahren zum Führen von Leitern von einer ersten Anordnung zu einer zweiten Anordnung, die um die erste Anordnung drehbar ist, mit den folgenden Schritten:
Anlenken der ersten Anordnung (2) an die zweite Anordnung (3) mittels eines hohlen Scharniers mit zwei getrennten parallelen Drehachsen (14, 15);
Passieren der Leiter von der ersten Anordnung (2) in das hohle Scharnier über eine Öffnung in der ersten Anordnung, welche um die erste Achse (14) der Scharnierdrehung zentriert ist;
Klemmen der Leiter an die erste Anordnung nächst der Stelle, wo sie aus dieser heraus- und in das hohle Scharnier eintreten;
Führen der Leiter in dem hohlen Scharnier längs einer geraden Bahn (45) zu der Öffnung, die um die zweite Achse (15) der Scharnierdrehung zentriert ist;
Klemmen der Leiter an das hohle Scharnier etwa in der Mitte der geradlinigen Bahn (45) derart, daß eine Gleitbewegung der Leiter längs dieser geradlinigen Bahn (45) ermöglicht ist;
Führen der Leiter aus dem hohlen Scharnier in die zweite Anordnung über eine Öffnung darin, welche um die zweite Achse (15) der Scharnierdrehung zentriert ist; und
Klemmen der Leiter an die zweite Anordnung (3) nächst der Stelle, wo sie in diese ein- und aus dem hohlen Scharnier austreten.

Revendications

1. Un calculateur portable à la main (1) ou similaire comprenant une première partie de boîtier (2),



un affichage (6) monté dans la première partie de boîtier,

un premier clavier (4) monté dans la première partie de boîtier,

une deuxième partie de boîtier (3), la première et la deuxième parties de boîtier étant accouplées à l'aide d'une charnière articulée (7),

caractérisé

en ce que ladite charnière (7) est creuse,

en ce que ladite charnière (7) comprend deux axes de rotation séparés et parallèles et est couplée autour du premier axe sur la première partie de boîtier (2) et autour du deuxième axe sur la deuxième partie de boîtier (3), en permettant ainsi un mouvement relatif d'une partie de boîtier autour de l'autre en pivotant d'un tour complet,

en ce qu'un deuxième clavier (5) est monté dans la deuxième partie de boîtier et

en ce que des conducteurs flexibles (19) passent à travers la charnière articulée creuse (7) afin de relier électriquement entre eux le premier et le deuxième claviers (2, 3).

2. Un calculateur portable à la main selon la revendication 1 dans lequel le moyen de conducteur flexible comprend des traces sur un circuit imprimé flexible.

3. Un calculateur portable à la main selon la revendication 2 dans lequel la première et la deuxième parties de boîtier (2, 3) et la charnière articulée creuse (7) incluent chacune un moyen de libération de contrainte afin de saisir légèrement le moyen de conducteur flexible et d'amener le moyen de conducteur flexible à être soumis à une flexion en torsion lorsque la première et la deuxième parties de boîtier sont soumises à un mouvement relatif l'une par rapport à l'autre.

4. Un calculateur portable à la main (1) ou similaire comprenant un ensemble de circuit imprimé flexible destiné à relier entre eux un premier et un deuxième ensembles dont l'un peut tourner par rapport à l'autre, le circuit imprimé flexible comprenant :

une première partie de boîtier (2) à monter sur le premier ensemble (17);

une deuxième partie de boîtier (3) à monter sur le deuxième ensemble (18);

une partie d'interconnexion comprenant une première et une deuxième sections parallèles (21, 22) assemblées entre elles à leurs extrémités par une section de transition (19), les sections parallèles (21, 22) étant assemblées à leurs autres extrémités à une extrémité

respective de la première ou de la deuxième parties,

caractérisé en ce que

la première et la deuxième sections parallèles (21, 22) sont à distance l'une de l'autre, en ce que la section de transition (19) chevauche ladite distance et en ce que la première et la deuxième sections parallèles (21, 22) sont d'une longueur et d'une étroitesse suffisantes pour permettre de les tordre sensiblement sans résistance d'au moins quatre vingt dix degrés sur leur longueur.

5. Un ensemble de circuit imprimé flexible selon la revendication 4 dans lequel la première et la deuxième sections parallèles et la section de transition sont en forme de U.

6. Un ensemble de circuit imprimé flexible selon la revendication 4 dans lequel la première et la deuxième sections parallèles s'approchent l'une de l'autre à partir de directions opposées et sont assemblées par une encoche abrupte formée par la section de transition.

7. Un ensemble de circuit imprimé flexible selon la revendication 4 comprenant en outre des feuilles de polyester sur lesquelles ont été déposés des conducteurs flexibles.

8. Un ensemble de circuit imprimé flexible selon la revendication 7 dans lequel les conducteurs flexibles sont des traces de cuivre gravé.

9. Un ensemble de circuit imprimé flexible selon la revendication 7 dans lequel les conducteurs flexibles sont des traces d'une pâte à teneur en argent.

10. Un ensemble de circuit imprimé flexible selon la revendication 4 comprenant en outre des dômes élastiques destinés à fabriquer des liaisons électriques en réponse à l'affaissement des dômes par l'application d'une pression mécanique.

11. Un procédé d'acheminement de conducteurs depuis un premier ensemble vers un deuxième ensemble, rotatif autour du premier, comprenant les étapes consistant à :

assembler entre eux à charnière le premier et le deuxième ensembles (2, 3) à l'aide d'une charnière articulée creuse (7), la charnière comprenant deux axes de rotation parallèles (14, 15);

faire passer les conducteurs depuis le premier ensemble (2) vers la charnière articulée creuse (7) à travers un orifice (12) du premier



ensemble centré autour d'un premier axe (14) de rotation à charnière;

serrer les conducteurs sur le premier ensemble (2) à proximité immédiate de l'emplacement où ils en sortent vers la charnière articulée creuse (7);

acheminer les conducteurs à l'intérieur de la charnière articulée creuse le long du premier axe (14) de rotation à charnière;

modifier l'acheminement des conducteurs afin qu'ils courent le long d'un deuxième axe (15) de rotation à charnière au lieu de continuer à courir le long du premier axe;

acheminer les conducteurs à l'intérieur de la charnière articulée creuse (7) le long du deuxième axe (15) de rotation à charnière;

serrer les conducteurs sur la charnière articulée creuse (7) à l'emplacement où l'acheminement des conducteurs est modifié et où ils courent le long du deuxième axe au lieu de courir le long du premier axe;

faire passer les conducteurs de la charnière articulée creuse (7) vers le deuxième ensemble (3) à travers un orifice (13) qui y est ménagé, centré autour du deuxième axe (15) de rotation à charnière; et

serrer les conducteurs du deuxième ensemble à proximité immédiate de l'emplacement où ils y entrent en provenant de la charnière articulée creuse (7).

12. Un procédé d'acheminement de conducteurs depuis un premier ensemble vers un deuxième ensemble, rotatif autour du premier, comprenant les étapes consistant à :

assembler entre eux à charnière le premier et le deuxième ensembles (2, 3) à l'aide d'une charnière articulée creuse (7), la charnière comprenant deux axes de rotation parallèles (14, 15);

faire passer les conducteurs depuis le premier ensemble (2) vers la charnière articulée creuse à travers un orifice du premier ensemble centré autour d'un premier axe (14) de rotation à charnière;

serrer les conducteurs sur le premier ensemble à proximité immédiate de l'emplacement où ils en sortent vers la charnière articulée creuse;

acheminer les conducteurs à l'intérieur de la charnière articulée creuse le long d'un trajet en ligne droite (45) vers l'orifice centré autour d'un deuxième axe (15) de rotation à charnière;

serrer les conducteurs sur la charnière articulée creuse à peu près au milieu du trajet en ligne droite (45) de manière à permettre un mouvement coulissant des conducteurs le long

dudit trajet en ligne droite (45);

faire passer les conducteurs depuis la charnière articulée creuse (7) vers le deuxième ensemble à travers un orifice qui y est ménagé, centré autour du deuxième axe (15) de rotation à charnière; et

serrer les conducteurs du deuxième ensemble (13) à proximité immédiate de l'emplacement où ils y entrent en provenant de la charnière articulée creuse (7).

