

ARRANGEMENT FOR THE GUIDANCE OF WIRES

5

The invention concerns an arrangement for the guidance of wires between two parts that may be rotated with a limited angle of motion with respect to each other, preferably for guiding a plurality of wires in a cable.

10

With arrangements like this particular problems are created with regard to laying of connecting cables or wires between the parts that may be rotated with respect to each other. Such a part could be a housing subassembly for a processing device and a support attached to it by means of a hinge, such as is the case in a wire bonder with rotatable bonding head. In such cases the laying of the cables or wires must take place in such a way, that, even with rapid swiveling motions with large swing angles no impermissible alternating stresses will occur.

15

20 This alternating stresses, which occur to a particular extent at the attachment points of the cable to the housing and the support, may lead to wire breaks, so that the function of the processing unit is no longer assured.

25

In order to assure the functional security of a cable connection for as long as possible, the cables are laid in the rotating axis within guides or without them. In both cases the cables should be as long as possible, in order to keep either the torsion or the bending loads on the cables within limits.

30

In case of ultrasonic wire bonders with rotatable bonding heads particular problems are created by the high rotating speeds and swing angles beyond 360° as well. In such arrangements the bonding head contains an ultrasonic swinger with an associated ultrasonic transmitter and an attached bonding tool (bonding wedge), whereat the connecting cable must carry out a plurality of tasks, such as supply of energy, transmission of measuring values, etc. If the cable is laid outside the axis

35

of rotation from the housing to the rotatable support with the bonding head, high acceleration speeds must be expected on the one hand, while on the other hand, the twisting motion of the support will cause the cable to wrap around the parts located
5 within the range of the swiveling motion or in the axis of rotation. This means, that the length of the cable must be sufficiently long in order not to be stretched when the respective end swiveling positions are reached.

10 In case of wire bonders with rotatable bonding heads there is a further problem in that the extremely thin bonding wire is guided in a guide channel in the axis of rotation of the bonding head, so that the cable guide may not cut in the axis of rotation.

15 In view of having the best possible dynamic characteristics of the wire bonders, the cable conduit should influence the inertia of masses as little as possible or not at all. Further to that the cable conduit must be designed in such a way that the
20 number of cycles of alternating stresses is not limited, if possible.

Therefore, it is common to use a cable conduit in which the cable is fixed by clamping it to the rotatable support of the
25 bonding head as well as to the rigid housing. When the support is swiveled, the entire cable is twisted, whereat it wraps itself in a spiral around the axis shell in the axis of rotation. In this, a relative motion between the individual strands or wires of a cable with each other and twisting of
30 the strands or wires with one another occurs. Thus, wear occurs, which considerably reduces the service life of the cable.

35 In order to circumvent these problems, at least in part, a cable conduit has become known from DE 37 39 957, in which a flat ribbon cable is used, which is laid around the circumference of the bonding head and wrapped around a rotatable drum running on bearings. In this way it is achieved that the flat

ribbon cable is wound and unwound with every rotation of the support. At the same time, the drum is driven by a traction wire cable connected to the support for the purpose of winding and unwinding the cable. This very elaborate solution considerably reduces the dynamism of the bonding unit.

Therefore, the invention is based on the task of designing an arrangement for the guidance of wires in which the disadvantages of the state-of-the-art are avoided and which, in particular, assures a low load on the strands or wires of a cable while providing a low moment of inertia.

This objective was achieved with this invention in such a way, that the wires on each part are guided through the same in a concentric or nearly concentric arrangement with respect to the axis of rotation are fixed, at least in part, in axial direction, so that the amount of the wire length between the parts is greater than the distance of the parts between each other, that the wires bulge together inwards or outwards with respect to the axis of rotation, and that the wires form a right-hand or left-hand spiral with an expanding pitch every time their end swiveling positions are reached.

The special arrangement of the wires of a cable about the axis of rotation and its length dimension between the parts has the effect that the alternating bending motions in the clamping areas are now well within the permissible alternating stress limits, so that a long service life of the cables is achieved. If the wires within the immediate vicinity of the axis of rotation are guided concentrically or nearly concentrically to it through the parts, this results in a particularly low moment of inertia, respectively an insignificant influence of the dynamic characteristics of the wire bonder. In the center position of the swiveling motion the individual wires are forming an approximate drum-shaped cage, which is transformed into a spiral with a high pitch when the end swiveling positions are reached.

Another particular advantage of the invention can be recognized in the fact that the axial distance between the parts can be kept as low as possible without limiting the function. Further to that, the number of wires of the cable to be guided
5 between the parts is not limited, so that the arrangement according to the invention is already fully functional without any limitation with only a single wire.

10 The length of the wires between the parts is appropriately dimensioned in such a way that the pitch of the spiral is as high as possible in the end swiveling positions, whereby the lowest possible alternating stress load is assured.

15 In one variation of the invention the parts are equipped with feed-throughs for the wires, which symmetrical axes with respect to the axis of rotation in the direction of the intended bulge of the wires are slightly pitched. This controls the direction of bulging, towards the outside or inside and is maintained over the entire service life of the cable.

20 In order to reduce the bending loads of the wires even further, they are clad with reinforcements within the feed-throughs which expand from the feed-throughs in the direction of the respective opposite feed-through in the shape of a funnel, for instance, in hyperbolic form.
25

In one execution of the invention the wires can be additionally fixed in the feed-throughs by means of a casting compound, which preferably should be elastic. This variation can
30 be realized quite simply and also results in a further reduction of the bending loads in the end swiveling positions.

Another variation of the invention is characterized by the fact, that the wires in the feed-throughs are fixed by means
35 of detachable round clips.

A special execution of the invention is characterized by the fact, that the connecting cable in the housing and in the sup-

port is connected to the respective wires by plug-type connectors. This enables a significantly easier assembly, at the same time making any possibly necessary repair easier, too. Preferably the connection of the connecting cable to the wires
5 is done with coaxial plugs, each of which are equipped with a central cutout to feed the feed-through for the bonding wire through.

10 If it is intended to feed multiple-strand or shielded cables from the housing to the support, it is useful to fix them on one side and guide them on the other side in the housing, respectively the support, in such a way that they are able to slide, for instance, by means of a sliding bearing.

15 The invention results, in comparison to the current state-of-the-art, in advantages which manifest themselves in considerably increased service life times, since the individual wires do not come into contact with each other during the rotating motion. This means, that the arrangement in accordance with
20 the invention works, to a large extent, free from wear.

The feed-through of the wires through the parts in the immediate vicinity of the axis of rotation results in particularly good dynamic characteristics, since the influence of the wires
25 on the moment of inertia of the bonding head is negligible.

A further advantage of the invention is that the number of wires leading from the housing to the support is limited only by the available space of the construction. In practice this
30 means, however, that a larger number of wires may be accommodated without any problem. In this way, the invention also fulfills possible future requirements, when a greater number of sensors and control elements is to be arranged on the bonding head.

35 In the following, the invention is explained with the aid of an application example. The associated drawings show:

Fig. 1 A schematic diagram showing a sectional view of a rotatable bonding head; and

5 Fig. 2 a plan view of the arrangement of the wires of the cable between two parts being rotatable in relation to each other.

10 Fig. 1 shows a rotatable attached support 2 for a bonding head 3 mounted on a housing 1, whereat the support 2 is connected to the housing 1 by means of a pivot bearing 4. On this bonding head, a transducer is hinged vertically swiveling to an extension arm of the support in a mounting 5. This transducer 6 comprises an ultrasonic transmitter 7 on one end and a bonding tool 8 for the attachment of the bonding wire 9 to contact
15 points on the other end.

The feeding of the bonding wire 9 to the bonding tool 8 is done by means of a wire guide 10 which is arranged in the axis of rotation 11 and which continues through the housing one and
20 the support 2. Below the support 2 there are deflection rollers 12, so that the bonding wire 9 may be fed in to the bonding tool 8 diagonally from the side.

25 A connecting cable, which is split up into its individual wires 14, is provided for the supply of energy to the ultrasonic transmitter 7 and for the transmission of control data and measuring values. Feed-throughs 15 for receiving and feeding through of one wire each are arranged concentrically to the axis of rotation 11 in the housing 1 as well as in the
30 support 2. The distance between the feed-throughs 15 to the axis of rotation 11 should be kept as small as possible.

35 The individual wires 14 are each fixed axially in the feed-throughs 15, which for example, may be achieved by means of an elastic casting compound 16 or by cable bushes. The connection of the wires 14 with elements of the bonding head 3 is not shown, since this may be executed at random.

As can be seen in the drawings, the length of the wires 14 has been selected longer than the distance between the housing 1 and the support 2, so that the wires 14 are bulging outward in the center position between both end swiveling positions.

5

Fig. 2 shows a plan view onto the star-shaped arrangement of a plurality of wires 14, whereat the feed-throughs 15 through the housing 1 and the support 2 are arranged in an orbit coaxial to the axis of rotation 11 in close proximity to the axis of rotation 11. The arrangement of the feed-throughs 15 may also be executed approximately coaxial to the axis of rotation. In this arrangement the feed-throughs 15 in the housing 1 and in the support 2 are aligned with each other. However, it is also possible to arrange the feed-throughs 15 on the housing 1 and the support 2 in different orbits.

10
15

As can be seen clearly in Fig. 1, the invention may be executed with just one single wire 14 or with a random plurality of wires 14. The number of wires is limited only by the circumference of the circular or elliptical orbit, in which the feed-throughs 15 must be arranged and by the diameter of the wires 14 to be fed through. In addition to that, the invention offers the particular advantage, that the surfaces of the housing 1 and the support 2 which are situated opposite each other do not necessarily have to be aligned parallel to each other.

20
25

Should in individual cases the number of wires 14 to be arranged be insufficient, there is, in principle, also the possibility to arrange them in two circular orbits about the axis of rotation 11, whereat care should be exercised that the wires 14 of one circular orbit do not come into contact with the wires of the other circular orbit when reaching the end swiveling position, which may be assured by defining a corresponding maximum diameter differential between the two circular orbits.

30
35

The radius of the circular orbit in which the feed-throughs are arranged should be dimensioned sufficiently large so that the pitch of the spiral of the wires 14 formed in the end swiveling position is as large as possible. However, in order to assure a moment of inertia as low as possible, respectively to keep the influence on the moment of inertia as low as possible, the radius should be selected as small as possible. In this way excessive bending loads of the wires are securely prevented.

In order to promote the intended bulging of the wires 14, which takes places automatically, the feed-throughs 15 for the wires 14 may be arranged in such a way, that the symmetrical axes in relation to the axis of rotation 11 are slightly angled in the direction of the intended bulge of the wires 14.

In the simplest execution of the invention, the feed-throughs 15 may be executed as simple bore holes, in which the wires 14 are fixed by means of a casting compound or by cable bushes. The cable bushes may be tapered towards the center of the pivot bearing or the cable bushes may also be expanding in the direction of the center of the pivot bearing.

Naturally it is also possible to use any other means, such as clips or collar-type receptacles without leaving the basic principle of the invention.

Even though the arrangement for the guidance of wires according to the invention has an extremely long service life, a significant simplification of the assembly and service may be achieved by fixing the connecting cable 13 to the housing 1 and the support 2 by means of bushes. The electrical connection of the connecting cables 13 with each other can be carried out simply by means of plug-type connectors which are interconnected by the wires 14. Coaxial plugs with a coaxial center opening may be used for this purpose, so that the feed-through 15 for the bonding wire 9 may be fed through the plug in axial direction.

One particular advantage of the invention may be seen in the fact that the individual wires 14 are not bundled as a complete cable and attached to the housing 1 and the support 2, but rather being treated individually. Thus, no twisting of the wires with each other occurs when the bonding head is rotated, but only bending and additionally, corresponding to the angle of rotation, a torsion of the wires about their symmetrical axis. The resulting alternating stresses of the individual wires is so low that no wear to speak of can be determined at all.

The described example of execution was based on the assumption that the connecting cable 13 between the parts which are rotatable in relation to each other may be split up into its individual wires. However, should a shielded cable or similar be routed to the bonding head, it would not be possible to realize this splitting.

Should a cable of this nature be attached to the housing 1 and the support 2 in the same manner as the wires 14, considerable alternating stresses and thus a significantly reduced service life would have to be expected.

In order to reach the same service life as with the guidance of individual wires with these cables as well, the cable 13 is fixed on one side only. Preferably, the connecting cable 13 is fixed to the support 2 and fed through the housing 1 by means of a sliding guide. Due to the sliding guide the cable is able to move freely in housing 1, so that a significantly extended torsion length is achieved. This extended torsion length results at the same time in a significantly reduced mechanical load on the cable. Since the sliding guide assures the necessary spatial fixation of the cable, this arrangement makes it absolutely possible to guide a shielded cable and at the same time individual wires between housing 1 and support 2.

5 In the initial position, i.e. in the center position between the end swiveling positions, the individual wires are bulging outwards, whereat the bulge is reduced and transforms into a spiral in the end swiveling position when the bonding head 3 is swiveling. When this takes place, the length of the wires 14 between the housing 1 and the support 2 must be dimensioned in such a way that the wires are not stretched in the respective end swiveling positions.

ARRANGEMENT FOR THE GUIDANCE OF WIRES

5

Legend

- | | | |
|----|----|------------------------|
| | 1 | Housing |
| | 2 | Support |
| 10 | 3 | Bonding Head |
| | 4 | Pivot Bearing |
| | 5 | Mounting |
| | 6 | Vibration Transmitter |
| | 7 | Ultrasonic Transmitter |
| 15 | 8 | Bonding Tool |
| | 9 | Bonding Wire |
| | 10 | Wire Guide |
| | 11 | Axis of Rotation |
| | 12 | Deflector Roller |
| 20 | 13 | Connecting Cable |
| | 14 | Wire |
| | 15 | Feed-Through |
| | 16 | Casting Compound |

Patent Claims

5

1. Arrangement for the guidance of wires between two parts that may be rotated with a limited angle of rotation with respect to each other, preferably for guiding a plurality of wires in a cable, characterized by the fact that,
- 10
- that the wires (14) on each part are guided concentrically or approximately concentric through this part and are fixed, at least in part, in the axial direction,
 - 15
 - that the length of the wires (14) between the parts is larger than the distance between the parts to each other,
 - 20
 - that the wires (14) are bulging together inwards or outwards in relation to the axis of rotation (11), and
 - 25
 - that the wires (14) form a right-hand or left-hand spiral with expanding pitch every time their end swiveling position is reached.
- 30 2. Arrangement in accordance with Claims 1, characterized by the fact that the parts are provided with feed-throughs (15) for the wires (14), having symmetrical axes which are slightly angled in relation to the axis of rotation (11) in the direction of the intended bulge of the wires (14).
- 35
3. Arrangement in accordance with Claims 1 and 2, characterized by the fact that the wires (14) are clad



with reinforcements within the feed-throughs (15), which expand funnel-like towards the respective opposite feed-throughs (15).

- 5 4. Arrangement in accordance with Claims 1 to 3, characterized by the fact that the wires (14) are fixed in the feed-throughs (15) by a casting compound (16).
- 10 5. Arrangement in accordance with Claim 4, characterized by the fact that the casting compound (16) is elastic.
- 15 6. Arrangement in accordance with Claims 1 to 3, characterized by the fact that the wires (14) are fixed in the feed-throughs (15) by means of detachable clips.
- 20 7. Arrangement in accordance with Claims 1 to 3, characterized by the fact that the connecting cable (13) in the housing (1), respectively the support (2) is connected to the wires (14) by means of plug-type connectors.
- 25 8. Arrangement in accordance with Claim 8, characterized by the fact that the connecting cable (13) is connected to the wires (14) by means of coaxial plugs, each of which has a central cutout for the purpose of accepting feed-through (15).
- 30 9. Arrangement in accordance with Claims 1 to 8, characterized by the fact that multiple-strand or shielded cables are fixed on one side and on the other side routed in a sliding guide in the housing (19 and in the support (2).
- 35 10. Arrangement in accordance with Claim 9, characterized by the fact that the cable is guided in a sliding bearing.



* C L M S *