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1

Coupling elements for frictionally connecting an external component to a shaft are known in many different forms.

DE-GM-18 95 907 discloses such a coupling element which serves for connecting two aligned and abutting shaft ends of the same diameter. This point of abutment is bridged by an internally cylindrical sleeve component fitting the ends of the shafts and being longitudinally slit at one point, and having on its outer surface a screw thread and a conical surface in series, the wall thickness of the thread increasing outwardly. The conical surface carries an unslit conical ring which is pressed onto the conical surface by a threaded ring screwed onto the threaded portion, the conical surface taking the hoop tension forces and connecting the sleeve component to the two shaft ends frictionally by radially compressing it.

In CH-PS 265 280 there is disclosed a coupling element which serves to couple a connecting flange to the shaft. Again there is a sleeve component with external conical surface and axially adjacent screw thread. A threaded ring draws the connecting flange onto the conical surface.

In one of the coupling elements according to FR-PS 13 61 776 the sleeve component is in the form of a double-coned ring of which the maximum wall thickness is in the middle and which bridges over the meeting point between two aligned shaft ends of the same diameter. Two unslit external coned rings are seated on the two outer conical surfaces and are drawn together by individual circumferentially distributed screws, and in this way the double-coned ring is radially clamped onto the ends of the shafts. In

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2

another embodiment only one simple coned ring is present, by which a radially projecting external component is unitarily connected. The external coned ring can be pulled onto the conical surface of the sleeve component by a number of circumferentially distributed screws which engage in the outer component.

A different embodiment is the subject of DE-OS 12 94 751. In this case the outer component has a cylindrical axial extension, on which is arranged a thin-walled thrust ring in the form of a double-coned ring, on the conical surfaces of which are seated two unslit coned rings which are drawn together by circumferentially distributed screws and clamp the thrust ring and the cylindrical extension on the shaft.

All the embodiments described have in common the use of screw threads together with conical surfaces, which produce the necessary axial displacement for frictionally clamping by means of the conical elements. The need for the presence of screw threads in addition to conical surfaces not only increases the outlay on manufacture but also makes assembly more difficult because large rotational paths have to be left available and this applies in the embodiments with the circumferentially distributed screws indeed in quite a substantial number of cases, to which must be added the problems with tilting during tightening.

The invention is based on solving the problem of providing a coupling element for frictionally connecting an external component to a shaft, which is simpler in construction and easier to use.

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3

This problem is solved by the invention stated in claim 1.

The clamping ring is rotated in relation to the sleeve component for securing the coupling element on the shaft, the spiral surfaces sliding over one another and by virtue of the inclination the sleeve component is radially compressed and is frictionally connected to the shaft. With suitable tolerances the required rotation of the clamping ring is only small and amounts, for example to a maximum of about 45° i.e. it needs only a single movement of a spanner engaging the ring in order to secure the coupling element and make it ready for use, as opposed to several rotations or in fact several rotations of a number of individual screws. Moreover, it does not need the clamping ring to be accessible from the face, i.e. the space taken up by the coupling element is substantially limited to the width of the clamping ring.

The rotational movement necessary for forcible frictional clamping depends also on the circumferential inclination of the spiral. However, in every case the inclination should be so small that the arrangement is self-jamming, i.e. no additional locking in the clamped condition is necessary.

Release of the coupling element is achieved by turning the clamping ring in the opposite direction to that for clamping. For this to occur the self-jamming action must be overcome, i.e. in some circumstances a substantial release torque must be applied.

In the clamped condition the clamping ring has its spiral surface in full face contact with the spiral surface of the sleeve component over a substantial part

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4

of its periphery, generally more than 315° . The engagement takes place uniformly with a relatively low force per unit area so that local overloading of the material can be avoided.

An arrangement with two spiral rings arranged one over the other in the space between the shaft and a recess in an outer component, and which produce a closing force by mutual relative rotation, is known in itself from GB-PS-293 122. However, this is not concerned with a coupling element in the context of the invention.

The torque which can be transmitted by the forcible engagement of the sleeve component on the shaft naturally depends on how tightly the clamping ring is turned. In order to increase the torque it can be advisable, in accordance with claim 2, to arrange a number of mutually independently operable clamping rings side-by-side on the spiral surface of the sleeve component (or several spiral surfaces mounted on it).

These clamping rings could then be tightened individually, which means that the available tightening torque, which is applied for example by hand, is then multiplied many times.

In a first embodiment coming into consideration a coupling functional element, for example a coupling flange or a toothed component designed to engage complementary teeth, is connected to the sleeve member.

In an alternative embodiment according to claim 4, two coupling elements according to the invention are connected together and form an actual coupling, by means of which two aligned or substantially aligned

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5

shaft ends can be connected together for mutual rotation.

The clamping ring can serve simply for clamping, in that it has a hexagonal or equivalent external surface. However, according to claim 5 it is also possible to introduce a torque in operation using an appropriate device, e.g. a toothed or chain periphery, whereby the connection can always pull itself tight in response to the torque.

In all the embodiments the radius of the spiral surface measured from the axis of the shaft increases in a circumferential direction proportional to angle, and then changes back at one point suddenly to the original radius. Generally speaking, this will occur after about 360° , but embodiments are not excluded in which the return step, looked at peripherally, occurs a number of times, for example at 180° .

With the coupling element tightened the points where the steps occur on the internal surface of the outer component and the external surface of the shaft are no longer adjacent but are circumferentially spaced apart by the amount of the angle of rotation which the arrangement requires from clearance fitting onto the shaft up to the point of it being clamped.

Between the transition surfaces of the inner surface of the outer component and the outer surface of the shaft there is left an open gap into which moisture and air can penetrate, and so corrosion can form on the peripheral surface in this region, in particular where the coupling element is employed in aggressive surroundings.

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6

When the coupling element is to be released the two peripheral surfaces formed by the spiral surfaces are turned back in relation to one another, the edges of the transition surfaces reaching the corroded region of the circumferential surfaces. This makes the release of the coupling element difficult or even impossible. It can lead to fretting of the region, adjacent to the edge, of each peripheral surface on the corroded part of the opposing surface.

Accordingly, there arises the further problem of arranging a coupling element of the kind described in such a way that release is no longer hindered in the manner described above.

This problem is solved by the construction given in claim 6.

Therefore, the spiral surface is omitted in a predetermined angular range inwards or outwards so that the edge of the transition surface from the smaller radius of the spiral surface to the greater one no longer engages the opposing surface but deliberately hangs in space. On reverse rotation of the components relative to one another the edge can no longer come up against the corroded region of the opposing surface and be held back by any roughnesses present on the surface.

The recesses, by means of which the edges of the transmission surfaces are deliberately left free, can, in accordance with the embodiment of claim 7, be cylindrical surfaces co-axial with the axis and relatively easily manufactured by milling whilst rotating the component relative to the axis.

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7

Embodiments of the invention by way of example are illustrated in the drawings.

Fig. 1 shows a longitudinal section on the axis through a first embodiment of the coupling elements, on the line I-I in Fig. 2;

Fig. 2 shows a view according to Fig. 1 looking from the left;

Fig. 3 shows a cross-section on the line III-III in Fig. 1 to a larger scale;

Fig. 4 shows another embodiment of the coupling element in longitudinal section.

Fig. 5 shows a longitudinal section through a complete coupling having two coupling elements;

Fig. 6 shows a section on the line VI-VI in Fig. 5;

Figs. 7 and 8 show views corresponding to Figs. 5 and 6 but of a further embodiment;

Figs. 9 to 11 show longitudinal sections and elevations of further couplings;

Fig. 12 shows a longitudinal section through a further embodiment of the coupling element;

Fig. 13 shows a section corresponding to Fig. 3 but of a modified embodiment.

The star-shaped disc indicated as a whole at 100 in Figs. 1 and 2 is designed for coupling to a shaft 1

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8

only indicated in Fig. 1 in broken lines. It comprises a flanged disc 11 provided with a bore 12 fitting the shaft 1 and having three arms 13 spaced apart by 120° , in which there are provided screw-threaded bores 14 spaced away from the axis 2 and serving for connecting to further components, for example a resilient clutch plate or the like.

A coupling element 10 is connected integrally to the flanged disc 11 in the manner of a hub and comprises a sleeve portion 3 having a cylindrical internal surface 4 aligned with the bore 12 in the flanged disc 11 and an external peripheral surface formed as a spiral surface 5 formed by a generator parallel to the axis 2 and having radial longitudinal slits 6 passing right through it and extending up to just before the flanged disc 11, at four points spaced apart circumferentially by 90° . A circumferentially closed clamping ring 8 which has a hexagonal surface 9 for receiving a spanner on its outer periphery is arranged on the spiral surface 5 and has an internal surface in the form of a corresponding spiral surface 7.

The sleeve portion 3 extends axially beyond the clamping ring 8 at the end furthest from the disc 11 and at that point it has an external circumferential groove 41 for receiving a spring ring 42 (Fig. 4) which is not shown in Fig. 1 and by which the clamping ring 8 can be retained on the sleeve portion 3 when it is in the unclamped condition.

The construction of the coupling element 10 is further explained in detail in conjunction with Fig 3. In the cross-section a notional cylindrical surface 15 having a diameter 16 is indicated in broken lines. The spiral surface 7 forming the internal peripheral

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9

surface of the clamping ring 8 lies in the first two quadrants of its cross-section outside the notional cylindrical surface 15 and in the last two quadrants it lies within it. The local radius of the spiral surface 7 and also of the spiral surface 5 decreases from the 12 O'clock position in Fig. 3 in a clockwise direction proportional to angle over almost 360° and then over a short circumferential stretch it changes back from a point 18 of minimum radius back to the maximum radius at the point 17. The difference in radius between the points 17 and 18 amounts, for example, to 2mm with a shaft 1 having a diameter of 100mm. Therefore, by rotation of the spiral surfaces 5, 7 relative to one another a radial tolerance of 0.2mm can therefore be bridged over an angle of 36° , and in most cases this is sufficient. The rotational travel for tightening which is contemplated will in no way have to exceed 45° .

The action of clamping can be illustrated by considering the point 20 of the sleeve portion 3 having the greatest wall thickness, that is to say the greatest radius of the spiral surface 5. On a movement of this point in a clockwise direction with the clamping ring of Fig. 3 held stationary it comes to lie progressively at points on the spiral surface 7 of increasingly smaller radius. In this way the point 20 is forced radially inwards and is frictionally clamped onto the shaft 1.

The formation of the external surface of the clamping ring 8 as a hexagonal spanner-engaging surface is only to be regarded as an example in the embodiment of Figs. 1 to 3 and the same is true of the further embodiments. It is naturally also possible to provide other shapes for simplifying rotation of the clamping

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10

ring 8, e.g. a cylindrical external surface having notches for engagement by a hook-type spanner or key.

In so far as the functionally equivalent parts are present in the further embodiment by way of example, the same reference numerals are employed.

In the coupling member according to Fig. 4, shown as a whole at 200, an externally toothed gear wheel 21 is integral with the coupling element 10, which is formed in the same manner as described in conjunction with Figs. 1 to 3, and the gear wheel has teeth 22 engaging in corresponding teeth 23 in a coupling sleeve 24.

In the coupling of Figs. 5 and 6 indicated as a whole at 300, there are two coupling elements 10 present, which have a dog clutch 30 on their mutually facing sides. The left hand coupling element 10 in Fig. 5 has as the clutch element on its right hand end a claw 25 which engages in a notch 26 between the limbs 27 of a fork on the left hand end, as viewed in Fig. 5, of the right hand coupling element 10 and thereby forms a mechanical drive connection.

In the coupling 400 in Figs. 7 and 8 the coupling elements 10 have axial extensions 28 with non-circular external surfaces, e.g. in the form of hexagons 29, which engage from both ends in a coupling sleeve 40 having a corresponding opening 31 and made of a resilient plastics material. By means of the coupling 400 the two shaft ends 1' and 1" can be connected together for joint rotation with a degree of damping.

In the coupling 500 of Fig. 9 again there are two coupling elements 10 present, which can be secured on

B

11

corresponding shaft ends and have as functionally coupling elements axial extensions 38 which have mutually opposed faces and have aligned bores 32 in them extending parallel to the axis to receive pins which bridge the gap and transmit the torque.

In the coupling 600 of Fig. 10 the sleeve portions 3 of the two coupling elements 10 are connected together by a hollow cylindrical connecting portion 34 in which a helical spring 36 is formed by an appropriate machining 35, forming a spring coupling 50 between the two coupling elements 10. Using the coupling 600 a certain degree of misalignment between the two shaft ends to be joined can be handled.

Also in the coupling 700 of Fig. 11 a hollow cylindrical connecting member 44 is present between the two coupling elements 10 and 10' but in this case it is rigid.

In the left-hand half of Fig. 11 a bevel pinion 37 having a thin-walled hub 39 is arranged on the shaft end 1' and the coupling element 10 is seated on this hub. When the coupling element 10 is tightened, therefore, the coupling 700 is connected on the one hand to the bevel pinion 37 and on the other hand to the shaft end 1'.

On the right-hand side of Fig. 11 the coupling element 101 which is present there has on the same spiral surface 5 of the sleeve portion 3 two clamping rings 8 side-by-side, both of which can be tightened up to a limiting torque and allow the torque which can be transmitted to the shaft end 1" to be increased. In the middle of Fig. 11 it is indicated in broken lines in the upper half that a torque can also engage the

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12

connecting member 4, for example in that it is formed as a sprocket 43 for a double-roller chain.

Moreover in the coupling 700 the diameter of the shaft end 1" is also greater than that of the shaft end 1' which can also be true of all the other embodiments.

In the embodiment 800 of Fig. 12 a chain sprocket 45 is secured on the shaft 1 by means of the coupling element 10. The clamping ring 8 of the coupling element 10 in this case, is not, as in the remaining embodiments, provided with a surface for engagement by a spanner, and which would serve only for the initial tightening of the coupling element 10 before it is actually put to use, and therefore before rotation of the shaft 1, but in this case the chain-sprocket 45 is applied to the clamping ring 8, through which, in use, that is to say with the shaft 1 rotating, a continuous torque is applied to the clamping ring 8. In this case the clamping ring 8 is in fact the hub of the sprocket 45. By appropriate orientation of the spiral surfaces 5, 7 in relation to the direction of rotation of the torque, the torque acts in a manner such as to pull the connection tighter all the time, the higher the torque loading. The initial tightening, in order to give an initial torque, can be performed by hand or equally well using a tool. Therefore, in the embodiment 800 the clamping ring 8 still has a function even during use of the coupling element 10.

In the star-shaped disc 100 of Figs. 1 to 3 there are four longitudinal slits 6 present, and this is to be understood as being only by way of example. In the other embodiments the sleeve portions are only slit at one point. It is only important that the spiral surfaces 5, 7 should be present axially in the region

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13

of the longitudinal slits, so that the generation of the radial squeezing force can take place in a region which is particularly easily deformed, and no great loss of force arises.

In Fig. 13 there is illustrated a form of the spiral surfaces 5, 7 which can be employed in the coupling elements of the embodiments described above.

In the sectioned illustration of Fig. 13 which corresponds to Fig. 3 the notional cylindrical surface 15 having the diameter 16 is indicated in broken lines. The spiral surface 7 forming the internal peripheral surface 13 of the clamping ring lies in the first two quadrants of the cross-section outside the notional cylindrical surface 15 and in the two last quadrants it lies within it. The local radius of the spiral surface 5 decreases from a point 17 of greatest radius in accordance with Fig. 2 in a clockwise direction proportional to angle over almost 360° and at a point 18 of minimum radius it returns over a transitional surface 19 back to the maximum radius. The transition surface 19 extends at a point 20 in the region of greatest wall thickness of the spiral surface 5.

The same applies to the spiral surface 7 which forms the internal surface 13 of the clamping ring 8. This goes from a point 51 of minimum radius through a transitional surface 19' at a point 52 into the region of greatest radius. An edge 50' is formed at the point 51.

From the starting position, in which the transition surfaces 19, 19' are mutually adjacent, up to the clamping position illustrated an angle 53 of about 35° has been taken up.

14

If the internal peripheral surface 13 of the clamping ring 8 were to continue in the sense of the spiral surface 7 between the transition surfaces 19, 19', this would occur in accordance with the notional surface 54. The continuation of the spiral surface 5 would be along the notional surface 55. With the clamping arrangement 10 in its tightened state the region 56 between the transition surfaces 19 and 19' is open, i.e. external moisture and corrosive atmospheres can penetrate. An internal peripheral surface 13 continued along the notional surface 54 would in some circumstances corrode in the region 57, and an external peripheral surface 11 continued along the surface 55 would corrode in the region 58. Then when the clamping arrangement comes to be released, which means a reverse rotation of the sleeve portion 3 in relation to the stationary clamping ring 8 in the direction of the arrow 59, the edges 20, 20' would come up against the corroded zones 57 and 58, which requires these points to be freed from corrosion products, or alternatively, the edges 20, 20' jamming on the corrosion products, which could lead to jamming of the arrangement and making release impossible.

In practice however the internal surface 13 of the clamping ring 8 has, starting from the transition surface 19' a recess 60 arranged outside the notional extension 54 of the spiral surface 7. This recess 60 is formed by a cylindrical surface which is concentric with the axis 2 and which, with a spacing outside the notional surface 54, joins on from the transition surface 19' or the point 52 in the sense of the displacement 61 in relation to the sleeve portion 3 resulting from release of the clamping arrangement, and extends over an angular region 2 which corresponds to the maximum relative angular rotation between the parts

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15

3 and 8 which arises on tightening, that is to say about 45°. Correspondingly, following on the transition surface 19 or the point 18 there is a recess 64 lying radially within the notional extension 55 of the spiral surface 5 and extending from the point 18 in the sense of the direction 65 in which the sleeve portion 3 would be rotated in relation to the stationary clamping ring 8 on loosening, extending over an angle 66 corresponding to the maximum angle arising on clamping.

In this way the two edges 20, 20' are left free in the manner which is evident in the drawing, and no resistances in the form of corroded material surfaces have to be overcome on release of the clamping arrangement.

The radial extent of the recesses 60, 64 is shown exaggerated in the drawing. An amount of 0.5 to 1mm of radial clearance is sufficient in practice.

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16



Claims

1. Coupling element for frictionally connecting an external component to a shaft (1, 1', 1"), having a sleeve portion (3) with its internal surface (4) designed for mounting on the shaft (1, 1', 1") and having a longitudinal slit (6) on at least a part of its length at at least one point, looked at in a circumferential direction, and having a rotatable circumferentially unslit clamping ring (8) arranged on the sleeve portion (3) at the height of the longitudinal slit (6), its internal peripheral surface co-operating with the external peripheral surface of the sleeve portion (3) whereby on rotation of the clamping ring (8) the sleeve portion (3) is radially compressed and is frictionally clamped onto the shaft (1, 1', 1"), characterised in that

a spiral surface (5) is arranged on the external peripheral surface of the sleeve portion (3) axially at the height of the longitudinal slit (6), connected to the sleeve portion (3), co-axial with the axis (2) of the internal peripheral surface of the sleeve portion (3) and formed by a generator parallel to the axis (2), as well as having a circumferential inclination lying in the self-jamming range and that the inner peripheral surface of the clamping ring (8) is a spiral surface (7) corresponding to the spiral surface (5) of the sleeve portion (3).

2. Coupling element according to claim 1, characterised in that a number of mutually independently operable clamping rings (8,8) are arranged side-by-side on the sleeve portion (3).

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17

3. Coupling element according to claim 1 or 2, characterised in that an element (11; 21; 25, 27; 28; 38, 34; 44) having a coupling or clutching function is connected to the sleeve portion 3.

4. Coupling element according to one of claims 1 to 3, characterised in that a further coupling element (10) which is of the same form and is arranged co-axially is connected to the coupling element (10) through coupling members (25, 27; 40; 33; 50; 44) for joining shaft ends (1', 1").

5. Coupling element according to one of claims 1 to 4, characterised in that a device (45) for applying a torque in operation is provided on the clamping ring (8).

6. Coupling element according to one of claims 1 to 5, characterised in that from the points (18, 52) of the transition of the circumferential surface (11, 13, from the currently maximum radius to the adjacent smaller radius in the releasing direction (61, 65) and over an angular range (62, 66) corresponding to the maximum angle of rotation, the peripheral surfaces (11 and 13) have recesses (64, 60) disposed radially within and without the notional continuations (54, 55) of the spiral surfaces (5, 7).

7. Coupling element according to claim 6, characterised in that the recesses (60, 64) are cylindrical surfaces having axes corresponding to the common axis (2) but of different radius.