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Taper Clamping Unit

From GB-PS 14 17 107 there is known a taper clamping unit with two co-operating taper rings of which the one has a radial flange in which are mounted axial clamping screws of which the head ends engage partially over the other taper ring and of which the edge of the head engages at one side in an outer circumferential groove in the other taper ring. On tightening or loosening of the clamping screws the heads of them press against the one or other flank of the peripheral groove.

This clamping unit is unsuitable for exerting large forces because the screws are only supported by one side of their heads and this results in high contact pressures at the points of contact as well as causing bending moments.

Taper clamping arrangements which do not represent self-contained taper clamping units but have similar features are shown by DE-PS-924 407 and US-PS 25 70 604.

A clamping unit having the features corresponding to the introductory part of claim 1 is shown by DE-A 24 44 104.

The invention is based on solving the problem of arranging a taper clamping unit of the kind defined in such a way that it is simple, variable and in a position to exert pure mechanical transmission of large forces.

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

By virtue of the fact that the flanks of the one taper ring or of the cylindrical bushing extend respectively in front of large parts of the engaging face of the associated peripheral flange, the peripheral flange has an almost full face abutment surface for both engaging faces in both directions of

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rotation, whereby on the one hand the surface pressures at the engaging faces are reduced and on the other hand the peripheral flange is loaded symmetrically so that no bending forces are exerted on the screws. The flanks of the recess should extend "abutting against axial forces" beyond the engaging faces, i.e. they should be backed-up in a stable manner by appropriate dimensions of the quantity of material so that they can also take forces. The aim of the invention is not fulfilled by flanks formed as side portions of sheet-metal thickness.

By virtue of the invention the screw is engaged in both directions of rotation by axial faces which are in position to transmit the forces of comparable magnitude. The screws serve both as clamping screws and as loosening screws. Therefore, it is no longer necessary to provide space for separate loosening screws, as was generally the case with the taper clamping connections known hitherto. The space thus obtained can be employed for further screws and thereby to increase the overall axial force that can be applied. The loosening of the clamping unit does not take place, as in most known designs, in that the ends of the loosening screws act against an abutment face. In such an arrangement the forces which can be transmitted are small and there is a danger of damaging the loosening screws. In the invention on the contrary the loosening takes place with the transmission of the forces against the engaging face of the peripheral flange, i.e. on a much greater surface and with correspondingly reduced pressure. Moreover all the screws which are present are available for applying the loosening force. The increased loosening forces, which are entirely comparable with the clamping forces, make it possible to employ particularly low angles of taper down to 2° . At low angles of taper the mechanical

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efficiency of the conversion of the axial clamping forces into radial clamping forces is particularly high, i.e. with given axial clamping forces particularly high torques can be transmitted relying purely on friction.

The recess serving to receive the peripheral flange, therefore for example of the head of the screw, is formed by two mutually separate components. The one flank of the recess is formed by the face of a taper ring, the other flank of the recess being formed by the one side of the end flange of the inner or outer bushing. This has the advantage on the one hand that with inner or outer bushings of different dimensions a matching of the diameter can be achieved without altering the taper components and on the other hand standard taper clamping units already currently commercially available or in use can be put to use in the manner according to the invention by the addition of the inner or outer bushing.

Overall the invention results in a taper clamping unit of exceptionally high performance but which can easily be released. The torque which can be transmitted per unit of weight is substantially higher than in the known arrangements.

The annular washers according to claim 2 are preferred in order to keep to a minimum the friction losses at the engaging faces of the peripheral projection of the screws. For example washers of hardened steel can be used and treated with a solid lubricant.

According to claim 3 the recess should receive the peripheral projection in an axial direction with only a small amount of play.

This offers particular security of tightening of the taper clamping arrangement. In the conventional taper clamping arrangements, where several screws are

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used distributed around the periphery, one has to keep carefully to a predetermined tightening sequence in order to prevent excessive tightening on one side leading to tilting of the taper clamping arrangement. With the narrowness of the recess according to the invention, if one screw is tightened and has caused a predetermined axial displacement of the conical components, after a small amount of travel in the region of 0.3 to 2.0 mm the adjacent screws come into engagement with the other side of their peripheral projection against the other flank of the recess and thereby prevent the further or excessive tightening of the first-mentioned screw. The result is an automatic and forcible balancing of the tightening of the screws.

In one important embodiment of the invention the peripheral projection is the head of a cap-head screw (claim 4).

The alternative is a kind of special screw according to claim 5 in which the shank extends both sides of the peripheral projection.

Whether the cut-out for the shank of the screw according to claim 6 is provided on one side or both sides of the recess depends on whether there is involved a cap screw or a "double-sided" screw.

The blind holes according to claim 7 signify that the end flange of the inner or outer bushing can be made substantially thicker so that any distortion by the axial releasing forces is counteracted.

The further feature according to claim 8 results in a kind of encapsulation of the peripheral projections or cap-screw heads which guards against contamination and corrosion.

In claims 9 to 12 there are revealed particular embodiments of clamping arrangements with additional cylindrical bushings of which the common advantage lies in the fact that on tightening of the clamping unit no

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displacement of the outer component in relation to the inner component in an axial direction takes place and the clamping units are always capable of positive release.

Some embodiments of the invention by way example are illustrated in the drawing.

Fig. 1 shows a partial section through the axis of a first embodiment of a clamping unit;

Figs. 2 and 3 show illustrations of further embodiments corresponding to Fig. 1;

Fig. 4 shows a partial view according to Fig. 3 with a detail modification;

Figs. 5 to 7 show sections through the axis of further embodiments formed as clamping units, the inner and outer components being omitted.

The clamping unit 100 in Fig. 1 serves for the forcible securing of an outer component 1 having a cylindrical opening 2 onto an inner component, for example a shaft 3, having a cylindrical outer surface 4. The opening 2 and the surface 4 are arranged concentrically and define between them a cylindrical space.

The clamping unit 100 is arranged in this space.

The clamping unit 100 in Fig 1 comprises a thick-walled taper ring 51 of which the cylindrical outer surface 52 engages in the opening 2 in the outer component 1, and which has a conical inner surface 9 and axial screw-threaded bores into which the screws 14 are inserted. The inner taper ring 53 on the other hand is of thin-walled construction and has a conical outer surface 17 which has the same cone angle, lying in the self-jamming range, as the conical surface 9 and engages the latter. In addition at the thicker end there is provided a flange 54 extending across the thin end of the ring 51 and the screws 42 extend through

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this flange and the heads 13 of the screws 14 bear against its outer face 22 from outside.

The taper rings 51, 53 together form a conventional clamping unit 50. However, the cylindrical inner surface 12 of the ring 53 does not, as is usual, engage the outer surface 4 of the shaft 3 but the outer surface 55 of a cylindrical bushing 56 which has, axially beyond the screw heads 13, a radial flange 57 which has a face 21 which is perpendicular to the axis and is towards the screw heads 13 and extends radially as far as the outer periphery of the screw heads 13, as well as having openings 27 for the passage of a torque-applying tool to engage the screw heads 13. The openings 27 are just wide enough for a tool to be inserted in the hexagonal recess in the screw head 13 to allow it to be turned in this way (Fig. 1 and 2) so that the shank 35 of the screw can just pass through it (Fig. 3). A recess 25 for receiving the screw head 13 is formed between the faces 21 and 22 of the flanges 57 and 54.

Each screw head 13 defines a peripheral projection which engages in the recess 25 in both axial directions. In this arrangement the top face of the screw head forms an engaging surface 31 which can co-operate with the face 21 of the recess 25 and the underside of the screw head 13 forms an engaging face 32 for the face 22.

When the screw 14 is tightened the taper rings 51, 53 are moved relative to one another and the two taper surfaces 9, 17 move over one another. In the embodiment by way of example the taper angle is about 3° . As a result of the relative sliding motion of the conical surfaces the clamping unit expands radially and thereby clamps the outer component 1 onto the shaft 3.

When, after having been tightened, the screws 14 are subsequently released, the clamping unit 100

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remains clamped because the angle of taper is self-jamming. It is therefore necessary to apply a positive axial releasing force in order to free the clamping unit 100. This occurs in that the screws 14 are unscrewed further until the engaging surfaces formed by the top faces of the screw heads 13 engage against the face 21 of the recess 25. On further rotation the taper ring 51 is thereby pulled away from the taper ring 53 and the clamping unit 100 is freed. The screws 14 thus serve both for tightening and also for freeing the clamping unit 100. They can be arranged around the periphery of the flange 18 as closely as desired, so that the entire available space can be employed for applying axial forces.

In the embodiment by way of example the width of the recess 25 between the faces 21 and 22 is only about 1 mm greater than the axial extent of the screw head 13 and the washer 16. Consequently when a particular screw 14 is tightened and has taken the taper ring 20 with it by this amount, the outer engaging surfaces 31 of the adjacent screws come up against the face 21 of the recesses 25 and in this way they restrict the further tightening of the first screw 14. In this way the tilting of the clamping unit 100 as it is tightened is prevented.

The clamping unit illustrated has a particular low weight for its performance i.e. the weight of the clamping unit which is needed for transmitting a predetermined torque is particularly low. This comes about because a particularly large number of screws can be employed as no space is wasted for separate releasing screws, and operation with a particularly low angle of taper is possible because the releasing forces which are then necessary and which can now be applied by the same screws can be achieved without difficulty.

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The bushing 56 can have various inside diameters in order to allow matching to different shaft diameters, as indicated in the left and right hand halves of Fig. 1. The advantage of this arrangement lies in the fact that standard available components can be employed for the clamping unit 51, 53.

Insofar as sectioned surfaces have not been hatched, this signifies that the taper ring in question can be slotted at one point in order to make it flexible and avoid losses of clamping forces of the screws 14.

Components having corresponding functions are indicated by the same reference numerals in the further embodiments by way of example.

In the embodiment 200 in Fig 2 the difference from the embodiment 100 of Fig. 1 lies in that the flange 57' of the bushing 56 is made axially thick and has blind holes 58 which receive the heads 13 of the screws 14 and form the recesses 25. The flange 57' engages the face or flank 22 of the flange 54 so that the heads 13 of the screws are to a certain extent encapsulated and protected.

In the clamping unit 200 the flange 57' can have a radial projection 37 against which the outer component 1 engages, so that as it is clamped it cannot become displaced in an axial direction in relation to the shaft 3.

In the embodiment 300 illustrated in Figs. 3 and 4 the screw 34 is not a cap screw but has a cylindrical peripheral projection or collar 33 concentric with the axis and engaging in the recess 25, the shank 35 of the screw being continued outwards and terminating in a hexagon head 36 lying clear of the outer face of the flange 18 and capable of engagement by a spanner.

Here again the tapered surface 19 forming the outer surface of the flange 18 can have a radially

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outwardly projecting extension 37 against which the outer component 1 comes into engagement axially. On tightening of the clamping unit 300 in this arrangement the cylindrical surfaces 2, 6 slide in relation to one another in addition, whereby however, the outer component 1 is not displaced axially in relation to the shaft 3, which in many cases is desired.

In Fig. 4 is indicated that the peripheral projection or collar 33 in the recess 25 can be provided on both faces with friction-reducing washers 16 made of hardened steel treated with solid lubricant. Such washers 16 could also be provided as support washers on one side in the embodiments of Figs 1 to 3.

In the embodiment 450 of Fig. 5 there is provided a bushing 56 formed as an internal bush which includes thin-walled cylindrical portion 56' of which the inner cylindrical surface is designed for engaging the shaft, not shown, and which has a cylindrical outer surface 65. On the left hand end as viewed in Fig. 5 there is provided a radially outwardly projecting end flange 57 in which is formed the recess 25 which either comprises individual cylindrical recesses which match the head 13 of each clamping screw 14 or however comprises a continuous peripheral groove into which the heads 13 project. An opening 27 for the passage of a wrench is provided opposite the heads 13.

As already explained, the cylindrical portion 56' is of thin-walled form and has in addition, as shown in Fig. 5, longitudinal slots 71 extending from the right up to just short of the end flange 56, increasing the flexibility so that not too much of the force of the screws 14 is lost in simply distorting the components of the clamping unit.

A radially thick-walled taper ring 61 is arranged with its cylindrical inner surface engaging the inner

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cylindrical outer surface 65 of the thin-walled part 56' of the bush 56, the expression "thick-walled" signifying here as in all the other embodiments, that the radial extent is sufficient in order to be able to accept a circumferentially closed axial bore for the clamping screws 14.

With its outer conical surface 72 having a cone angle lying in the self-jamming range the taper ring 61 engages the inner conical surface 73 of a thin-walled taper ring 63, of which the cylindrical outer surface 64 is designed to engage in a corresponding bore in an outer component, not illustrated.

At its left-hand end as viewed in Fig. 5 the taper ring 63 has a radially inwardly projecting flange which engages radially from outside between the right hand face of the end flange 65 and the left-hand face of the taper ring 61. The axial screws 14 pass through the flange 66 in through-bores 74 and engage in screw-threaded bores 75 in the taper ring 61.

The components 61, 63, 14 form a conventional clamping unit 60 within the clamping unit 450, which co-operates with the bush 56 and can be combined with bushes 56 of different wall thicknesses in order to be able to cover a corresponding range of shaft diameters.

On tightening of the screws 14 the taper ring 61 is drawn in between the taper ring 63 and the cylindrical part 56' of the bush 56. The cylindrical inner surface of the part 56' and the outer surface 64 of the taper ring 63 in this arrangement are not displaced axially, which is an important advantage insofar as the components which are to be clamped together maintain the relative axial position in which they have been set.

So that the bush 56 is not carried to the left in Fig. 5 by the taper ring 61 as it is tightened, at

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least two connecting screws 67 are provided, distributed around the periphery, operable from the same side as the screws 14 and passing through clearance bores 68 in the flange 67 to engage in threaded bores 69 in the flange 66 of the taper ring 63. The flanges 66, 57 are therefore held in engagement against the face 59 so that the above-mentioned displacement of the bush 56 to the left cannot take place.

The connecting screws 67 also have a function during loosening. When the screws 14 are unscrewed for this purpose it can happen that the outer component could be urged rearwards away from the cylindrical part 56' of the bush 56, maintaining the clamping between the taper ring 63 and the taper ring 61. In this arrangement the flange 56 would be moved away from the flange 57, and the connecting screws 67 prevent this happening. The outer component and the clamping unit 60 are therefore not able to shift as a packet but on the contrary on appropriate actuation of the screws 14 there is a positive release of the clamping unit 60 and thereby of the whole clamping arrangement 450.

In the embodiment 800 of Fig. 6 there is arranged on the thin-walled part 56' of the bush 56 a thick-walled taper ring 71 which has the end face of its thicker end towards the end flange 57. A thin-walled taper ring 88 is seated on the taper ring 81 and has a flange 86 on its right hand end in Fig. 6, projecting radially inwards and in fact as far as the face 76 of the part 56' of the bush 56. The taper rings 81, 88 form a conventional clamping unit 70.

When the screws 14 are tightened the thick-walled taper ring 81, in contrast to the embodiment 450, is forced from left to right between the part 56' of the bush 56 and the thin-walled taper ring 88. On account of the engagement against the face 76 in this

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arrangement the taper ring 88 maintains its position in relation to the shaft, not shown, so that here again once the axial position of the components in relation to one another has been set it is not altered by the tightening sequence.

In the embodiment 900 of Fig. 7 there is added, in comparison with the embodiment 800 of Fig. 6, a further taper ring arrangement at the right hand end of it. Apart from this, however, the embodiment 800 is on its left hand side of Fig. 7 completely contained in the embodiment 900 and accordingly the components carry the same reference numerals. The taper ring 88 is extended to form a double-taper ring 90, in that a taper ring portion 98 is added at the right hand end. Overall the double taper ring 90 has a T-shaped form in a cross-section through the axis, the flange 86 of Fig. 6 forming a central web 96 of which the inner surface has a sliding engagement on the shaft. The inner conical surface 93 of the taper ring portion 98 co-operates with a thick-walled taper ring 91 of which the inner peripheral surface extends as far as the shaft, not shown.

There is provided a first set of screws 14 which pass through clearance bores 82 in a first thick-walled taper ring 81 and engage in threaded bore 83 in the central web 86. The screws 14 clamp the taper rings 81 and 88.

There is present a second set of clamping screws 14' which pass through clearance bores 82 in the taper ring 81 and 84 in the central web 96 and engage in threaded bores 85 in the additional right hand taper ring 91. The screws 14' clamp the taper rings 98 and 91.

On release, first the taper ring 91 is forced away from the taper ring 98 by the screws 14'. Subsequently, the withdrawal of the screws 14 and

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disengagement of the taper rings 88 and 81 takes place. Connecting screws 67 could be provided between the taper ring 81 and the end flange 57, as illustrated in Fig. 5. However, it is also possible to make the cone angle of the taper surface 93 on the right hand side of Fig. 7 somewhat greater than the conical surface 92. Then when an axial forces arises the taper ring 91 always releases first.

With regard to the function of the recess 25 and the extent of its faces 21, 22, all the above-mentioned embodiments correspond to the recess 25 of Figs. 1 and 2.

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C l a i m s

1. Taper clamping unit for introduction in the space (50) between the cylindrical opening (2) of an outer component(1) and the cylindrical external surface (4) of an inner component (3),

with a first taper ring (53,20,63) having a peripheral surface (17,73) formed as a self-jamming conical surface and a cylindrical peripheral surface (12,64),

with a second taper ring (51,10,61,88) with a conical surface (9,72) engaging the first conical surface (17,73) and having the same cone angle and a cylindrical peripheral surface (52,6,62),

with circumferentially distributed screws (14,34) which each have a peripheral projection (13,33) with engaging faces (31,32) projecting radially beyond the shank of the screw on both sides and perpendicular to the axis,

with axial screw-threaded bores (11,75) in the second taper ring, in which the threads of the screws engage,

with a face (22) perpendicular to the axis on the first taper ring (53,20,63) against which the circumferential projections (13, 33) of the screws (14, 34) engage on tightening,

the faces (22) supporting against axial forces over the whole radial extent of the opposing engaging face (32) of the peripheral projection (13) of the screw (14) and

the components (1,3) being capable of clamping to one another on tightening of the screws (13, 34) with the engagement of one (32) of the engaging faces of the circumferential projection (13, 33) against the face

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(22) of the first taper ring (53, 20) and with relative sliding movement of the conical surfaces (9, 17),

characterised in that

the taper clamping unit (100,200,300,450,800,900) includes a cylindrical internal or external bushing (56) which engages against one (12,62) of the cylindrical peripheral faces of the taper rings and has a radial end flange (57, 27) which extends with a second face (21) perpendicular to the axis in front of the peripheral projections (31,33) of the screws (14,34),

that also the second face (21) extends in a manner abutting against axial forces respectively up to beyond the entire radial extent of the opposing engaging face (31,32) of the associated circumferential projection (13,33)

and that the components (1,3) are disengageable from one another on release of the screws (14, 34) with engagement of the other engaging face (31) of the circumferential projection (13,33) against the face (21) of the end flange (57,57').

2. Taper clamping unit according to claim 1, characterised in that there is provided on at least one of the engaging faces (31,32) of the circumferential projection (13,33) a washer (16) for easing the rotation of the screw (14,34) in the presence of axial forces.

3. Taper clamping unit according to claim 1 or 2, characterised in that the width of the recess (25) from face (21) to face (22) is 0.3 to 2.00 mm greater than the width of the circumferential projection (13,33).



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4. Taper clamping unit according to one of claims 1 to 3, characterised in that the circumferential projection (13) is the head of a cylindrical cap screw (14).

5. Taper clamping unit according to one of claims 1 to 3 characterised in that the circumferential projection (339) is provided within the longitudinal extent of the screw (34) and the shank extends both sides of it.

6. Taper clamping unit according to one of claims 1 to 5, characterised in that at least one of the faces (21,22) which axially define the recess (25) has a radially outwardly open opening (27,28) for receiving the shank (15,35) of the screw.

7. Taper clamping unit according to one of claims 1 to 6, characterised in that the end flange (57') has blind holes (58), of which the bottoms form one face (21) of the recess (25), on that side which is towards the circumferential projections (13) for receiving the circumferential projections (13).

8. Taper clamping unit according to claim 7, characterised in that the end flange (57') engages with the edges of the blind holes (58) against the face of the one taper ring (53).

9. Taper clamping unit according to one of claims 1 to 8, characterised in that it has a two-part taper clamping unit (60) of which one taper ring (63) forms the cylindrical outer surface (64) of the taper clamping unit (60) and has on the end which is towards the end flange (57) of the cylindrical bush (56) a radially inwardly projecting flange (66) and of which

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the other taper ring (61) is of thick-walled form and has a cylindrical inner surface (62) engaging the cylindrical outer surface (65) of the bush (56) as well as an outer conical surface (72) co-operating with the inner conical surface (73) of the first taper ring (63), and that the screws (14) pass through clearance bores (74) in the flange (66) to engage in screw-threaded bores (75) in the thick-walled taper ring (61).

10. Taper clamping unit according to one of claims 1 to 8, characterised in that it includes a two-part taper clamping unit (70) of which one taper ring (88) forms the cylindrical outer surface of the taper clamping unit (70) and has on the end which is away from the end flange (57) of the cylindrical bush (56) a radially inwardly projecting flange (86) which axially outside the end of the cylindrical bush (56) extends radially as far as its face (76), and of which the other taper ring (81) is of thick-walled form and has a cylindrical inner surface engaging the cylindrical outer surface of the cylindrical bush (56) as well as an outer conical surface co-operating with the inner conical surface of the first taper ring, and that the screws (14) pass through clearance bores in thick-walled taper ring (81) to engage in screw-threaded bores in the flange (86).

11. Taper clamping unit according to claim 9 or 10, characterised in that short connecting screws (67) are provided, distributed circumferentially and engaging from the end flange (57) into the flange (66).

12. Taper clamping unit according to one of claims 1 to 8, characterised in that it includes a double taper clamping unit which has a thin-walled



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double taper ring (90) of which the greatest wall thickness lies axially in the middle and there has a radial central web (96) which extends axially clear of the end of the cylindrical bush (56) radially as far as its face (76), and two thick-walled taper rings (81,91) co-operating with it, of which the first (81) has a cylindrical surface engaging the cylindrical surface of the bush (56) and its conical surface engaging one of the conical surfaces of the double taper ring (90) and of which the second has its cylindrical surface engaging the cylindrical surface of the component to be clamped and its conical surface engaging the other conical surface (98) of the double taper ring (90), and that two sets of circumferentially distributed clamping screws (14,14') are provided, of which the circumferential projections (13) are arranged on the end flange (57) and of which the first set pass through clearance bores (82) in the first thick-walled taper ring (81) and the central web (96) and engage in threaded bores (85) in the second thick-walled taper ring and of which the second set pass through clearance bores (82) in the first taper ring and engage in threaded bores (83) in the central web (96).