

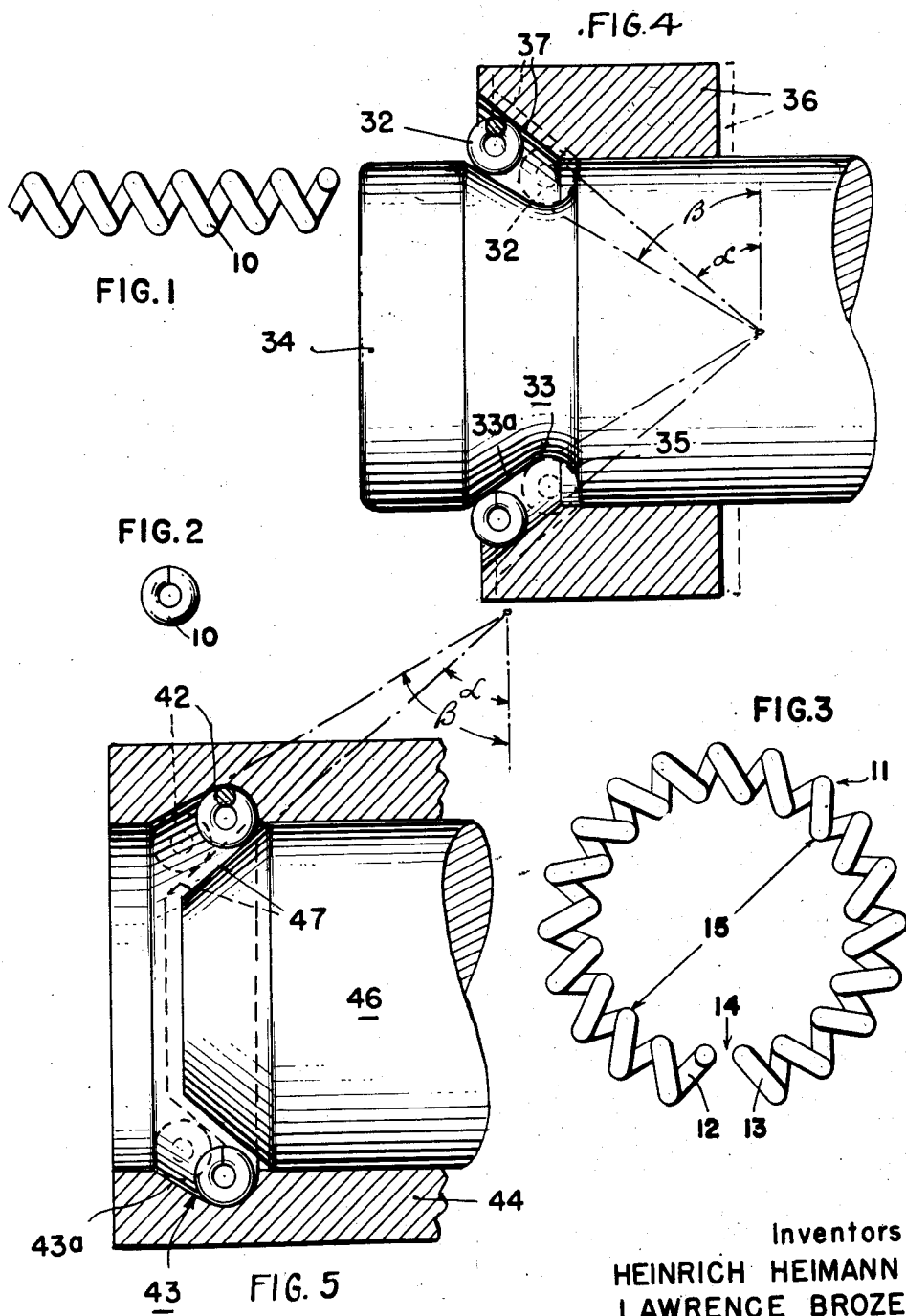
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SPRING RETAINING RING FOR MACHINE PARTS

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SPRING RETAINING RING FOR MACHINE PARTS

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This invention relates to improvements in retaining ring assemblies of the type in which a machine part mounted on or in a carrier such as a shaft or housing is located and secured in fixed position and against axial displacement by a spring retaining ring of split or open-ended annular form capable, when spring-seated in a groove provided in said carrier, of providing an artificial shoulder for said machine part.

Conventional retaining assemblies as aforesaid heretofore employed retaining rings characterized by solid section throughout their circumference, being either fashioned from strips or wire of uniform (round, square or rectangular) section which are bent to ring formation, or blanked from strips or sheets to open-ended annular form, with section heights decreasing from the middle portion of the ring to the free ends which define the ring gap, so that the ring deforms circularly. Both of the aforesaid ring types have a definite limitation in the degree which they can be spread or contracted in assembly without taking on a permanent set, which depends on the maximum section width of said rings. It is obvious also that for secure seating and ability to provide an effective shoulder the ring section must have substantial height. As a consequence, the capacity of the ring to spread or contract is relatively small, because the working stresses must not exceed the yield strength of the ring material to avoid a permanent set. Thus, for rings of uniform section height, the degree of spreading or contracting is limited to 5-7% of ring diameter, while tapered rings have only a slightly greater spreading or contracting capacity of from 10-14%.

Another disadvantage in the use of conventional retaining rings in such assemblies is that, since the variations in diameter which split or open rings of solid section allow for a given ring dimension are very small, the prior retaining ring was individually dimensioned to a particular size shaft or housing bore and could not be effectively used with shafts or housings having even a slightly different size than that for which the ring was designed. Furthermore, it is the very nature of conventional retaining rings that they require special tools for assembly and disassembly, and they cannot be easily adjusted to solve the prob-

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lem of taking up any considerable end play of the machine part intended to be located thereby.

A principal object of the present invention is the provision of a retaining ring assembly of the above referred to class employing a retaining ring which is free of the aforementioned limitations and disadvantages of conventional retaining rings of solid section, which uses, instead, a retaining ring which may have a spreading or contracting capacity up to 100% of ring diameter instead of from 10-14% as with the prior tapered retaining ring, without the danger of the ring taking on a permanent set.

Another object of the invention is the provision of a novel retaining ring assembly employing a coiled-wire retaining ring as herein described, which is constructed and arranged to take up end play of the machine part to be located, up to the sum total of the tolerances likely to be encountered or required in such assemblies.

Yet another object of the invention is the provision of a novel retaining ring assembly made possible by the use of a coiled-wire retaining ring and which has the capacity of taking up end play between the machine part located by said ring and its carrier to a substantially higher degree than possible in the prior assemblies employing a beveled retaining ring especially designed for such purpose, i. e. a tapered ring having a bevel face along its groove-seating edge, and which functions as a wedge in its groove, so as to apply an axial force on the machine part abutted thereby. Due to the modest groove depth required for such a ring and the fact that the angle of face bevel must not exceed 15° for security reasons, the capacity of a tapered ring of approximately 1" free diameter to take up end play does not exceed .005"; and for smaller ring diameters this capacity decreases still further to the point of being practically negligible, with the result that even the tapered ring of the beveled type aforesaid is effective to take up but a fraction of the total end play likely to be encountered in retaining ring assemblies. In sharp contrast thereto, the improved retaining ring assembly of the invention, due to use therein of a coiled-wire retaining ring and accompanying novel structure and relationship of the parts making up the same, has the capacity of taking

up the total of the end play occurring or likely to occur in such assemblies.

The above and other objects and advantages of the invention will be seen from the following detailed description taken with the accompanying drawings, in which:

Figs. 1 and 2 are partial plan and end views, respectively, of a straight length of helically coiled wire of round section from which a coiled wire retaining ring as shown in Fig. 3 is fashioned;

Fig. 3 is a plan view of an external coiled wire retaining ring according to the invention.

Fig. 4 is a side view, partly in section, of a retaining ring assembly of the invention consisting of carrier shaft, coiled wire retaining ring, and machine part located by the latter, the view illustrating the manner in which the retaining ring is capable of taking up end play of the machine part; and

Fig. 5 is a similar view illustrating another form of retaining ring assembly employing an internal ring and the manner in which an internal coiled wire ring may be employed to take up end play of the machine part located thereby in a carrier housing.

Referring first to Figs. 1, 2 and 3 of the drawings, illustrating an external ring employed in one form of improved retaining ring assembly of the invention, such retaining ring, as distinguished from the prior retaining rings of solid section, is of preformed coiled wire construction, being preferably fashioned from a straight length of helically coiled wire 10 (Fig. 1) having an appropriate number of windings, which is bent to open-ended ring or annulus form 11 (Fig. 3) of predetermined, constant radius, with its free ends 12, 13 defining a small-width gap 14. Following bending to ring form, the coil is heat-treated, i. e., hardened and tempered, with the result that the coil maintains its annular or ring shape in which it is unstressed, having a free diameter which is calculated to be considerably smaller than the diameter of the bottom of the semi-circular groove of the shaft on which the ring is to be assembled. The ring under consideration, being of the external type, may be assembled as usual or it can be spread over the shaft directly in the plane of its groove and released to seat in said groove. Due to the smaller free diameter of the ring relative to groove diameter, the ring is spread or expanded when seated, the gap 14 between the free ends 12, 13 increasing in width according to the shaft diameter. Accordingly, the ring exerts considerable pressure against the bottom of its groove due to the spring temper imparted to it, with the result that the ring securely seats itself when assembled. Preferably, the depth of the groove is such that when the ring is seated, it protrudes from the shaft circle for approximately half its winding diameter, thus forming an artificial shoulder on the shaft capable of locating and securing a machine part against axial displacement thereon.

It is obvious that the degree of spreading that such a ring can take if dimensioned correctly is very large. By "dimensioned correctly" is meant the correct determination of the number of windings, the cross-section of the wire (its diameter in case of a round wire) and the mean diameter of the windings for the required degree of spreading (in case of the external ring) or contracting (in case of the internal ring). If so dimensioned, the working stresses cannot exceed

the yield point of the coiled wire making up the ring so that the danger of permanent set is eliminated, on the one hand, while, on the other hand, sufficient seating pressure of ring against groove bottom may be achieved.

The above referred to internal ring, which is adapted to seat in a groove provided in the bore wall of a carrier housing, follows the construction of the described external ring. However, in the case of the internal ring, it is formed with a free diameter which is larger than the diameter of the bottom circle of the housing bore groove, and hence has a wide gap between its open ends so that the ring can be contracted in assembly and disassembly, and in assembly may expand to seat with spring pressure in its groove. This seat pressure and the degree of contraction that the coiled-wire internal ring can take depends on the correct dimensioning of the ring, as outlined above in connection with the external coiled-wire ring.

An assembly employing a retaining ring of the invention in either the external or internal form may result in end play between the retaining ring and the machine part located thereby, which end play may reach the sum total of the tolerances in the overall length of the machine part, the winding diameter of the ring and the axial location of the groove in shaft. The combined tolerances aforesaid can be considerable and may exceed the allowable end play, and there are also other applications which allow no end play. To deal with this problem, the invention provides a novel form of assembly designed to positively take up end play, which is illustrated in Fig. 4 for the external ring, and in Fig. 5 for the internal ring.

In Fig. 4, an external coiled wire ring 32 as shown in Fig. 3 is seated in a groove 33 provided in the ring carrier such as shaft 34. The shaft groove 33 is formed with an inclined (conical) ring-engaging outer wall 33a which is a section of an elongated cone having a cone angle β with respect to a normal to the shaft axis, and terminates in a rounded edge 35 forming a groove inner wall. A machine part 36 located by the ring is provided with a cone-like ring-abutting surface (chamfer) 37 having a cone angle α with respect to the aforesaid normal and which is smaller than the cone angle β of cone 33a. The difference between angles β and α has to be so chosen that under thrust of the machine part 36 against ring 32, the ring cannot slip out of its groove but, instead, locks itself under friction between the abutting conical surfaces 33a and 37. This difference is calculated as follows: if the friction coefficient μ is larger than the value

$$\tan \frac{\beta - \alpha}{2}$$

no slipping of the ring along the cone surfaces 33a and 37 can occur under any thrust. Assuming μ equals .12, which is a fair value for friction of metal against metal, then

$$\tan \frac{\beta - \alpha}{2}$$

should be smaller than .12;

$$\frac{\beta - \alpha}{2}$$

is therefore approximately smaller than 7° and therefore $\beta - \alpha$ is not in excess of 14° .

If the tolerances in the length of the machine part, the location of the groove and the wind-

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ing diameter reach the total such that machine part in relation to the groove takes the position indicated in dotted lines (Fig. 4), the coiled wire retaining ring will ride down the conical wall 33a of its groove under its spring tension and take a changed position indicated in dotted lines, in which it still seats on the conical wall 33a of the groove and abuts against cone surface 37 of the machine part.

In Fig. 5, the same result of ring taking up end play is achieved by the internal coiled wire ring 42 seated in a groove 43 of a housing 44, the ring providing an internal shoulder for locating a machine part 46. The housing bore groove 43 is provided with a conical outer wall 43a having a cone angle β with respect to a normal to the housing bore axis as in Fig. 4, and the abutting or overhanging face of the machine part 47 having a cone angle α with respect to a normal to the housing bore axis, also as in Fig. 4. The ring 42, in tending to shift on the cone surface 43a of the groove, is capable of taking up end play to the sum total of the aforesaid tolerances, as with the external ring assembly of Fig. 4.

The axial end play that the rings 32 and 42 can take up is determined by the winding diameter of said rings, the angle of inclination of groove wall (33a and 43a) and the angle of the chamfer (37 or 47) of the machine part. If we assume an allowable outermost position of said rings, corresponding to their full line positions in both Figs. 4 and 5, and an innermost position as indicated in dotted lines, then the vertical difference between outermost and innermost positions can be easily held to $\frac{3}{4}$ of the winding diameter. Accordingly, the axial end play the ring can take equals $\frac{3}{4}d \times (\tan \beta - \tan \alpha)$. Thus, if the winding diameter is $\frac{1}{8}$ in., the angle $\beta = 60^\circ$, the angle $\alpha = 48^\circ$, then the end play could be .089. For a shaft of 1 in. diameter, the end play to be taken up by a coiled wire ring of the invention, seated in a conical-wall groove and abutting against a conical surface (chamfer) of the machine part to be located, would be a multiple of (in the example, approximately 16 times) the end play a tapered split ring of solid section can take up. This property makes such a ring, which according to the difference between angles β and α as above is always self-locking, an especially capable substitute for threaded bolts and nuts subject to end play.

We are aware of the fact that closed coiled wire rings, i. e. full circular rings, are known as retaining rings, but such closed rings have a distinct disadvantage for use in retaining ring assemblies, as compared with split or open-ended coiled wire rings as herein proposed. In the first place, the allowable degree of spreading or contracting, measured in percentage of diameter change, is considerably smaller than can be achieved with the present open-ended ring, being smaller in approximately the same ratio as the capacity for deformation is smaller in closed solid rings than in split retaining rings of solid section. Secondly, the prior closed coiled wire ring is open to the objection that it tends under thrust to roll over the shaft with very diminishing friction rather than to slide along the surface of the shaft. This property makes the closed coil wire ring insecure under thrust, even when it is seated in a relatively deep groove. Such unfavorable rolling effect under thrust cannot occur when a coiled wire, split or open-ended ring is used in the retaining ring assemblies according to the invention, because there is no transmis-

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sion of torque at its free ends, a fact which has been verified in tests made by us on both external and internal coiled wire rings of the present open-ended type.

Without further analysis, it will be appreciated that the use of a split, coiled wire ring in assemblies and according to the relationship of this present invention achieves the objectives set forth in the foregoing. When properly dimensioned, such a ring may have a spreading or contracting capacity of 100% of its diameter, instead of from 10-14% as in the case of prior tapered rings of solid section, without the danger of the ring taking a permanent set. The open-ended coiled-wire ring may be readily assembled and disassembled by hand, because the forces required for this purpose are relatively small as compared with conventional retaining rings, such a ring at the same time being capable of exerting adequate pressure against the bottom of its seating groove as required for security under thrust. Moreover, the open-ended coiled-wire ring may be more easily assembled than the conventional retaining rings of solid section and, due to its high allowable spreading capacity, may be assembled on its shaft by spreading the same over the shaft directly in the plane of its seating groove. Also, in assemblies of the invention which employ the improved coiled wire ring of the invention, the ring is capable of taking up a multiple of the end play that can be taken up by prior tapered rings acting on a wedge, this in addition to its substantially greater spreading capacity and materially lower force required for its deformation.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A retaining ring assembly including a machine part carrier provided with an annular groove having an outer conical wall, a machine part carried by said carrier and positioned with an end face overhanging the inner wall of said groove, said end face having a conical surface, the conical outer wall of the groove and the conical surface of said end face providing ring seating and ring abutment surfaces, respectively, and a retaining ring seating on said seating surface and protruding from said groove so as to abut against the aforesaid abutment surface, thereby to locate said machine part and secure it against axial displacement with respect to the carrier, said retaining ring comprising a length of helically coiled wire extending along an arc of substantially constant radius and having its ends spaced from one another, said ring having a free diameter in which said wire is unstressed but being stressed when seated as aforesaid so as to have pressure fit against the conical outer wall of the groove, the inclination of said conical outer wall being such as to cause the retaining ring to tend to slide axially inwardly towards the groove inner wall, and the angle of inclination which said conical outer wall bears to a normal to the axis of the carrier being greater than the corresponding angle which the conical surface of said machine part end face bears to said normal.

2. A retaining ring assembly as set forth in claim 1, wherein the angle of inclination which the conical outer wall of the groove bears to the

normal is not more than 15° greater than the corresponding angle which the conical surface of said machine part end face bears to said normal.

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Number
1,810,093
2,255,217
2,423,848

5

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,741,093	Briggs	Dec. 24, 1929

Number
21,745
851,146
538,821
247,513

10

Name	Date
Timson	June 16, 1931
Hill	Sept. 9, 1941
O'Connor	July 15, 1947

FOREIGN PATENTS

Country	Date
Great Britain	Oct. 6, 1902
France	Jan. 3, 1940
Germany	Nov. 17, 1931
Switzerland	Mar. 15, 1947