3,077,811 CONTINUOUS RETAINING RING ADAPTED FOR RADIAL EXPANSION

This invention relates to a retaining ring for use in the assembly of mechanical parts. The preferred form of ring which will be described in detail below to exemplify the invention has been developed as a retaining ring especially suited for securing the blades in turbine and compressor rotors, but, as will also be evident from the description which follows, the retaining ring of the invention is inherently capable of establishing other mechanical connections that can be formed by a retaining ring adapted for expansion and contraction as desired.

The most common form of retaining ring used in the past is the resilient ring that can be snapped into locking position. However, resilient members and devices have the disadvantage that they are unsuitable under certain environmental conditions. Normal spring steel loses its temper and resilience when subjected to radioactive radiation, for example. The same results flow from exposure of the steel to high temperatures or to the thermal fatigue of operation over a large temperature range.

In order to provide a retaining ring not subject to these disadvantages, it is the primary object of the present invention to construct a device which, while performing satisfactorily as a retaining ring, is constructed of an essentially non-resilient material.

This object is achieved according to the invention by forming a retaining ring as a continuous annulus defining a main plane extending transversely to the axis about which the annulus is described, said annulus having a peripheral working edge and a plurality of mutually circumferentially spaced expansion zones disposed around the annulus, each of said zones comprising a portion of the annulus spaced radially from the working edge, said portions being plastically deformable between contracted and expanded conditions, the expanded condition being such that the plastically deformable portions are displaced axially from said main plane and the working edge is in a contracted condition of lesser circumference than such maximum circumference.

Further features of the invention will appear from the specific description below of two forms of retaining ring constructed in accordance with the present invention. In connection with such specific description, reference should be made to the accompanying drawings, in which:

FIGURE 1 is a front elevation view of a first form of retaining ring according to the invention, showing the ring in its contracted condition;

FIGURE 2 is an enlarged view of a small zone of the ring shown in FIGURE 1;

FIGURE 3 is a section on the line III—III in FIGURE 2;

FIGURE 4 is a section on the line IV—IV in FIGURE 2;

FIGURES 5, 6 and 7 correspond respectively to FIGURES 2, 3 and 4, but show the ring in its expanded condition, FIGURES 6 and 7 being sections on the lines VI—VI and VII—VII respectively in FIGURE 5;

FIGURE 8 is a front view of a portion of the ring of FIGURES 1 to 7 shown in its expanded condition in a turbine rotor;

FIGURE 9 is a view on the line IX—IX in FIGURE 8;

FIGURE 10 is a view of a portion of an alternative construction of retaining ring, showing the ring in its expanded condition; and

FIGURE 11 is a further view of the portion of ring shown in FIGURE 10, but in the contracted condition. Reference will first be made to FIGURES 1 to 7.

These figures show a retaining ring in the form of a continuous annulus 10. The steel of which the annulus is constructed is generally rectangular in cross-section, and the annulus may be said to define a single main plane P extending transversely of the central axis about which the annulus is described. The annulus 10 has a substantially continuous, "working," outer peripheral edge 11 which is designed to be expanded into an inwardly facing slot, as will later appear. Disposed around the annulus 10 at convenient, spaced intervals, is a series of expansion zones, one of which is shown within the rectangle R of FIGURE 1 and on a large scale in FIGURE 2.

These expansion zones are all alike, and each comprises a portion 12 which is spaced radially inwardly from the working edge 11 and which is plastically deformable between an expanded and contracted condition. Each portion 12 is shown in its contracted condition in FIGURES 1 to 4 and in its expanded condition in FIGURES 5 to 7. The contracted condition is such that the plastically deformable portion 12 is displaced axially from the main plane P (as FIGURES 3 and 4 demonstrate). As a result, the working edge 11 is also in a "contracted" condition of minimum circumference.

So that the working edge 11 will always form an almost completely circular circle, notwithstanding the fact that the deformable portions 12 are radially inwardly spaced from it, there is arranged outwardly of each of the deformable portions 12 a pair of auxiliary edge portions 13 which about one another in the contracted condition of the annulus to render the working edge 11 effectively continuous. These auxiliary edge portions 13 lie at all times in the main plane P, being separated from their associated deformable portion 12 by a slot 14.

To bring the working edge 11 to the "expanded" condition, all the deformable portions 12 are hammered or otherwise forced to lie in the main plane P (FIGS. 5 to 7), which action separates the ends of the auxiliary edge portions 13 and causes the working edge 11 to adopt a maximum effective circumference. The reference to an "expanded" and a "contracted" condition thus refers principally to the condition of the annulus as a whole, and in particular to its working edge 11; however, for convenience of description, the deformable portions 12 are considered each to have an "expanded" and a "contracted" condition corresponding respectively to the expanded and contracted conditions of the annulus.

The metal of which the annulus 10 is constructed must necessarily be plastically deformable, and one of the readily available, comparatively ductile mild steels is well suited to the purpose. Any tendency to springiness or resiliency in the material should be avoided, since, as explained above, one of the essential advantages of the present invention is that it does not depend on the maintenance of resiliency in the metal.

An important practical consideration in the construction of the annulus 10 is the maintenance of a substantially uniform cross-section around the periphery, or at least a cross-section having no sudden or sharp changes in shape or area. Undesirable stress concentrations are avoided in this way and distortion of the ring under extreme temperature conditions is not experienced. It should be noted that, in determining the effective cross-section of the annulus 10 at any point around its periphery, the auxiliary edge portions 13 should be ignored, since they do not
3 form part of the continuous, stress-transmitting metal of the
annulus. The proper comparison is between the
cross-section of the deformable portions 12 and the cross-
section of the intermediate portions 15 which extend be-
tween each of the expansion zones.

As FIGURES 2 and 5 demonstrate, the annulus is rel-
ieved (cut away) in circumferential alignment with the
deformable portions 12 to render the cross-section of the inter-
mediate portions 15 less than it would otherwise be.

One convenient manner in which the ring of FIGURES
1 to 7 may be employed in practice, is illustrated in FIG-
URES 8 and 9 where the annulus 10 is shown in expanded
condition with its working edge 11 expanded into a slot
16 formed beneath the overhanging ends 17 of rotor mem-
bers 18 between which slots are formed to receive and
retain the blade roots 19. Radial movement of the blades
out of the slots is prevented by the undercut shape of the
slots, in the usual way, the retaining rings 10 serving to
prevent axial sliding of the blade roots 19 out of these
slots.

To assemble the ring with the other parts, it is brought
into alignment with the slot 16 while still in its contracted
condition, and then each of the deformable portions 12 is
struck a blow or series of blows to deform it plastically
into its expanded condition. Preferably all the expansion
zones are expanded simultaneously, this being accom-
plished by using a specially constructed annular punch to
engage all the deformable portions 12 simultaneously,
hammer blows or other thrust on this punch forcing all
the portions 12 axially substantially simultaneously. Al-
ternatively, each portion 12 may be deformed independent-
ly using simply a hammer and punch.

The embodiment of the invention so far described in-
volves a retaining ring which is expanded into its locking
position, and this will be the more usual form of retain-
ing ring required in practice. It is nevertheless within
the scope of the present invention for a retaining ring
to be contracted into its working position and a section of
such an alternative form of ring is shown in FIGURES
10 and 11. Here, the ring consists of an annulus 20
formed with a working edge 21 which time is formed
at the inner periphery instead of the outer periphery where
the working edge 11 appeared. As in the case of the
annulus 10, the annulus 20 is provided around its pe-
riphery with a series of expansion zones, only one of
which is shown in FIGURES 10 and 11. Each such ex-
ansion zone comprises a plastically deformable portion
12 generally similar to the plastically deformable portions
12. FIGURE 10 shows a portion 22 in its expanded
condition, lying flat in the main plane P, while FIGURE
11 shows a portion 22 deformed into its contracted con-
dition distorted axially from said main plane. Auxiliary
edge portions 23 are provided, as before, and these are
separated from the deformable portion 22 by a slot 24.
Intermediate portions 25 interconnect adjacent expansion
zones.

In addition to its reversal of structure, the alternative
form of ring shown in FIGURES 10 and 11 is differently
used in practice, since each of the deformable portions 22 is
moved from its expanded to its contracted condition,
after the ring has been placed in position with the parts
requiring to be retained, whereas the deformable por-
tions 13 of the first embodiment of the invention are each
moved from contracted to expanded condition when the
ring is used for its intended function. Such deformation
of portions 22 to their contracted conditions will pref-
erably also be carried out simultaneously by the application
of the necessary thrust applied through a tool designed
to bear simultaneously on each such portion 22 only of
the ring 20. Alternatively, each portion 22 may be de-
formed independently by the application of a suitable
vice grip.

The example given herein of one practical use of a re-
taining ring according to the invention is merely intended
to illustrate one possible application. The device has ap-
lication in any assembly in which parts are to be held
in place by means of a ring that can be moved between
a locking and a release position by being expanded and
contracted, or vice versa. Depending on which periph-
eral edge is chosen as the working edge, the ring may
either be expanded or contracted into its locking position.
Thus, in referring herein, and in the appended claims, to
the deformable portions, and hence the annulus as a whole,
being movable between contracted and expanded condi-
tions, movement in both directions (i.e. both towards ex-
panded, and towards contracted) is contemplated.

I claim:

1. A retaining ring comprising a continuous annulus
defining a main plane extending transverse to the axis
about which the annulus is described, said annulus hav-
ing a peripheral working edge and a plurality of mutuall
circumferentially spaced expansion zones disposed around
the annulus, each of said zones comprising a portion of
the annulus spaced radially from the working edge, said
portions being plastically deformable between contracted
and expanded conditions, a pair of auxiliary edge por-
tions located at each expansion zone and lying in said
main plane radially spaced from the plastically deform-
able portion of said expansion zone, said auxiliary edge
portions projecting towards each other from the portions
of said annulus on each side of the plastically deformable
portion of said expansion zone and forming continuations
of said working edge whereby to render the same nearly
continuous even in the expanded condition, the expanded
condition being such that the plastically deformable por-
tions all lie in the same main plane and the working edge
is in an expanded condition of maximum circumference,
and the contracted condition being such that the plastically
deformable portions are displaced axially from said main
plane and the working edge is in a contracted condition
of lesser circumference than such maximum circumference.

2. A retaining ring according to claim 1, wherein the
effective, stress-transmitting cross-section of said annulus
is substantially constant around its entire extent, and is
free from sudden changes of shape.

3. A retaining ring according to claim 1, wherein said
working edge is the outer peripheral edge of the annulus,
said plastically deformable portions being spaced radially
inwardly from said edge.

4. A retaining ring according to claim 1, wherein said
working edge is the inner peripheral edge of the annulus,
said plastically deformable portions being spaced radially
outwardly from said edge.

5. A retaining ring according to claim 1, wherein the
intermediate portions of said annulus lying between the
expansion zones are relieved in circumferential alignment
with said deformable portions.

References Cited in the file of this patent

UNITED STATES PATENTS

1,694,354 Rollason ____________ Dec. 4, 1928
2,860,540 Karlsson ____________ Nov. 18, 1958