Feb. 19, 1963 E. S. MOORE 3,077,811

CONTINUOUS RETAINING RING ADAPTED FOR RADIAL EXPANSION

Filed Aug. 8, 1960 2 Sheets-Sheet 1

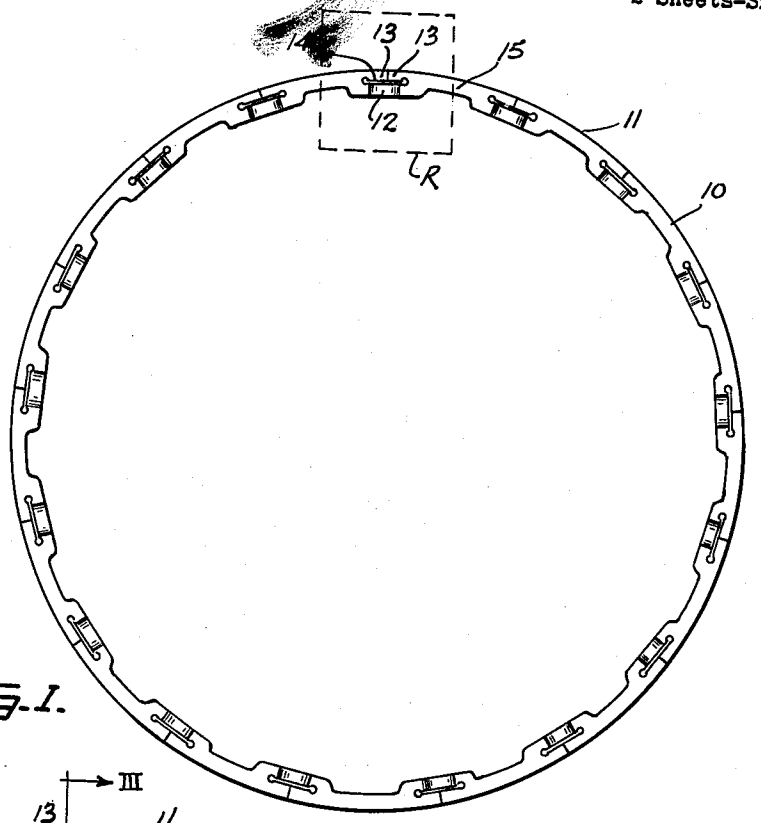


Fig. 1.

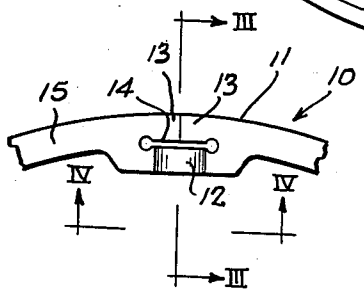


Fig. 2.

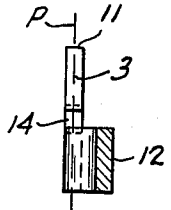


Fig. 3.

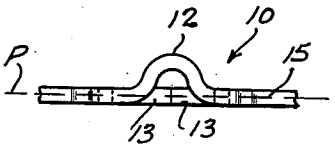


Fig. 4.

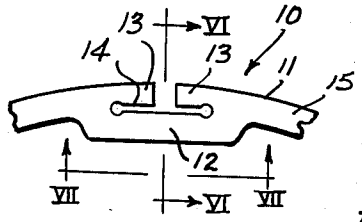


Fig. 5.

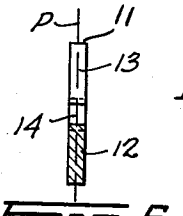


Fig. 6.

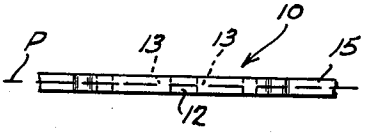


Fig. 7.

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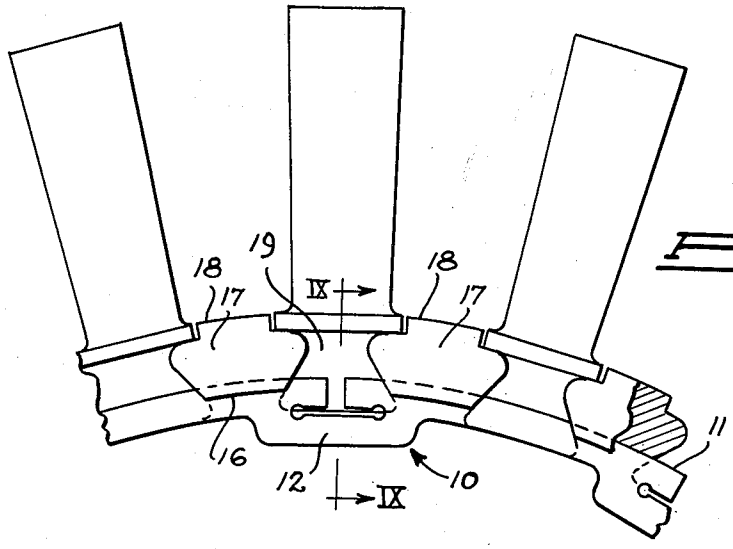


Fig. 8.

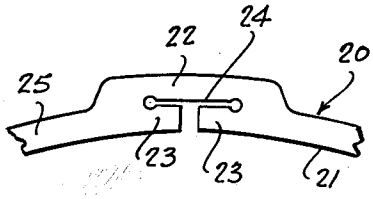


Fig. 10.

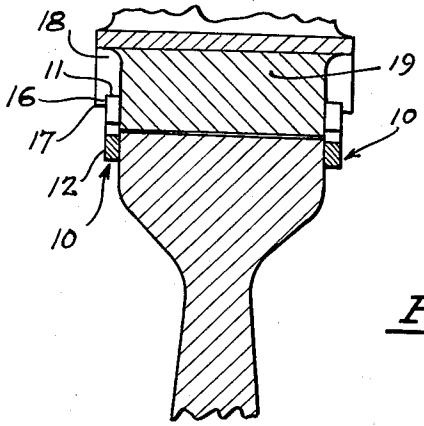


Fig. 9.

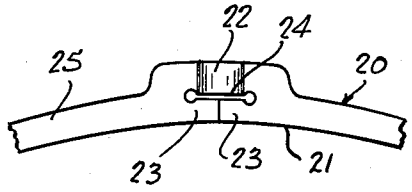


Fig. 11.

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CONTINUOUS RETAINING RING ADAPTED FOR RADIAL EXPANSION

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Filed Aug. 8, 1960, Ser. No. 48,254
5 Claims. (Cl. 85—8.6)

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 result flows 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 transverse 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 all lie in said 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 each 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 4. 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 FIGURES 2 to 7.

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 continuous 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 resilience 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

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 between each of the expansion zones.

As FIGURES 2 and 5 demonstrate, the annulus is relieved (cut away) in circumferential alignment with the deformable portions 12 to render the cross-section of the intermediate 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 FIGURES 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 members 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 accomplished 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. Alternatively, each portion 12 may be deformed independently using simply a hammer and punch.

The embodiment of the invention so far described involves a retaining ring which is expanded into its locking position, and this will be the more usual form of retaining 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 this 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 periphery with a series of expansion zones, only one of which is shown in FIGURES 10 and 11. Each such expansion zone comprises a plastically deformable portion 22 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 condition 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 portions 12 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 preferably 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 deformed independently by the application of a suitable vice grip.

The example given herein of one practical use of a retaining ring according to the invention is merely intended to illustrate one possible application. The device has application 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 peripheral 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 conditions, movement in both directions (i.e. both towards expanded, 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 having a peripheral working edge and a plurality of mutally 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 portions located at each expansion zone and lying in said main plane radially spaced from the plastically deformable 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 portions 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.

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