July 16, 1963 E. JORDAN 3,097,679

SPLIT SELF-LOCKING WASHER

Filed Dec. 7, 1959 3 Sheets-Sheet 1

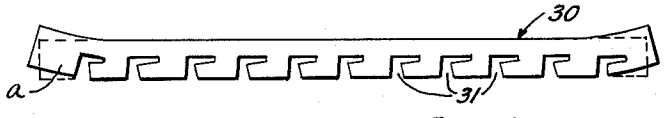


FIG. 1

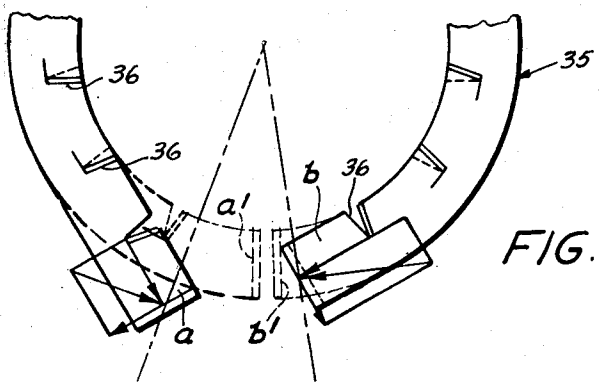


FIG. 2.

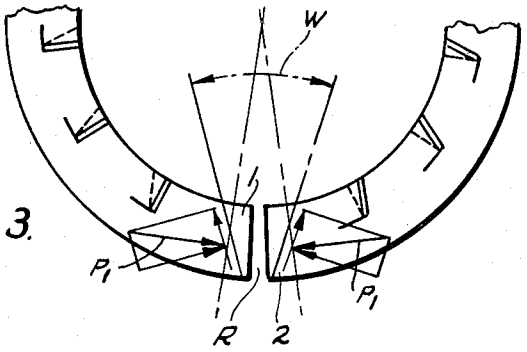


FIG. 3.

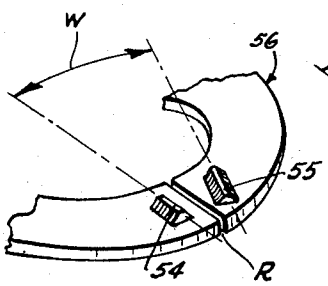


FIG. 4.

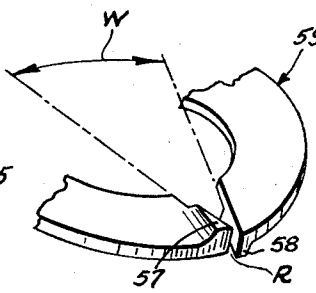


FIG. 5.

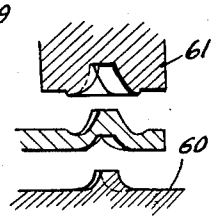


FIG. 6.

INVENTOR
ERNST JORDAN
BY Robertson and Voutie
ATTORNEYS

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SPLIT SELF-LOCKING WASHER

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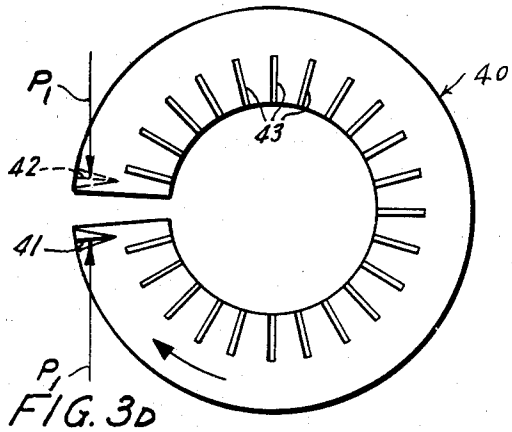


FIG. 3D

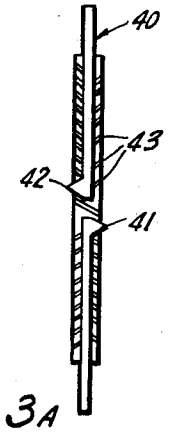


FIG. 3A

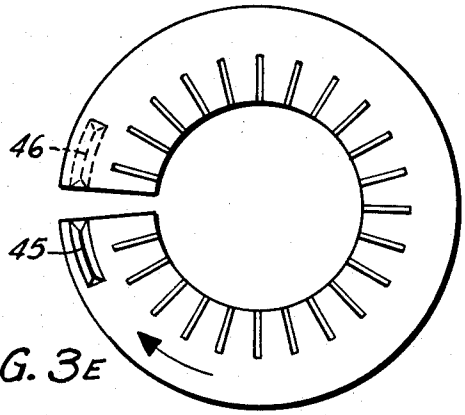


FIG. 3E

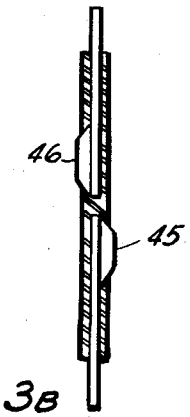


FIG. 3B

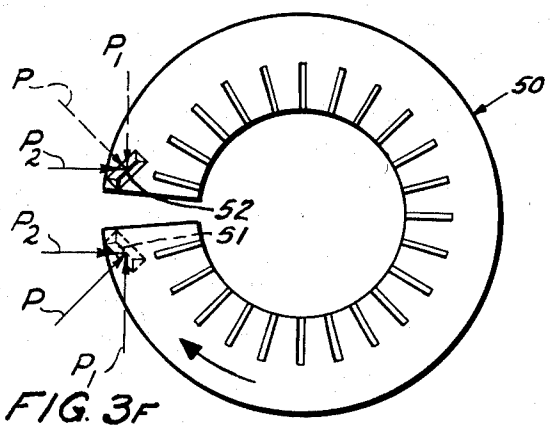


FIG. 3F

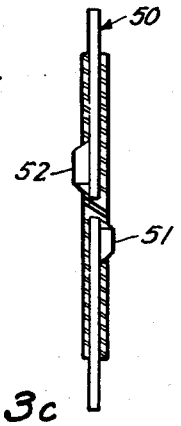


FIG. 3C

INVENTOR
ERNST JORDAN
BY Robertson and Pontius
ATTORNEYS

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SPLIT SELF-LOCKING WASHER

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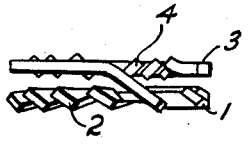


FIG. 7.

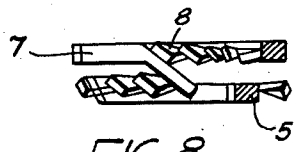


FIG. 8.

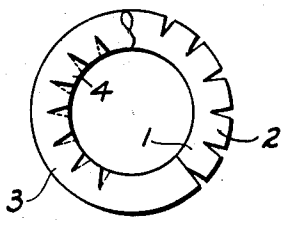


FIG. 7A.

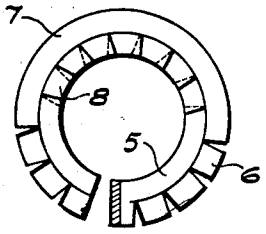


FIG. 8A.

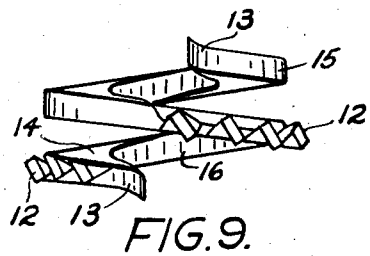


FIG. 9.

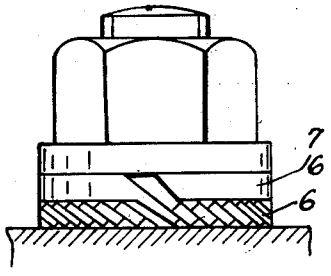


FIG. 10.

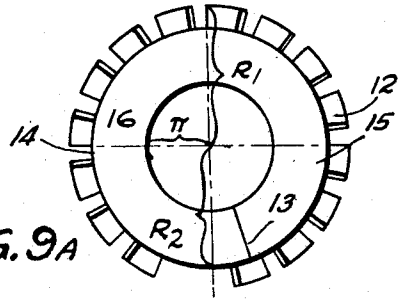


FIG. 9A

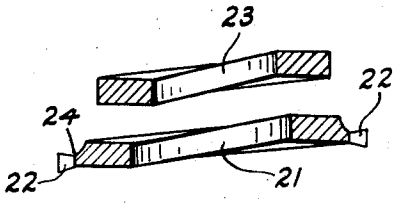


FIG. 11.

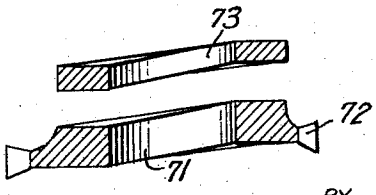


FIG. 12

INVENTOR
ERNST JORDAN
BY Robertson and Voutie
ATTORNEYS

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SPLIT SELF-LOCKING WASHER

Ernst Jordan, Leinpfad 17, Hamburg 39, Germany

Filed Dec. 7, 1959, Ser. No. 857,806
7 Claims. (Cl. 151—36)

This invention relates to a split self-locking washer or ring with teeth and biting edges for securing a nut on a bolt.

Split self-locking washers or rings with radial locking sections or teeth are already known to the art. On either side of the gap these known split self-locking rings are provided with biting edges which are intended to bite into the underface of the nut and into the co-operating face of the member which carries the bolt. However, self-locking rings of this kind suffer from the defect that when the nut is screwed on to the ring the upwardly and downwardly directed biting edges and, when the nut tightens on the obliquely placed teeth, said teeth fail to prevent the ends of the split ring from being forced apart and the ring from thus opening. When this is the case the intended locking action of the ring is, of course, nullified. The provision of the known type of biting edges across the entire width of the ring actually promotes a tendency of the ring to splay open.

It is therefore the object of the present invention, in rings of the aforesaid kind, to arrange the biting edges, or ridges which have a like effect, at both ends of the ring in such a way that they will strongly oppose any tendency of the ring to splay open. It must also be borne in mind that as a result of the cutting effect of the locking teeth the structure of the material forming the roots of the teeth is destroyed, so that pressure of the nut on the teeth is likely to cause their migration out of a radial position, i.e. splaying of the ring and enlargement of its diameter.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described, and of which the scope will be indicated by the appended claims.

In the drawings:

FIGURE 1 is a plan view of a strip illustrating a principle employed in the present invention;

FIGURE 2 is a partial plan view showing a conventional lock washer, and illustrating splaying or enlargement thereof in use;

FIGURE 3 is a partial plan view of a lock washer, and diagrammatically illustrating the dynamic principles of the instant invention;

FIGURES 3A, 3B and 3C are side views showing three embodiments of washers constructed in accordance with the teachings of the present invention;

FIGURES 3D, 3E and 3F are plan views of the washers of FIGURES 3A, 3B and 3C, respectively;

FIGURE 4 is a partial perspective view showing another modification of washer constructed in accordance with the instant invention;

FIGURE 5 is a partial perspective view showing still a further modification of washer of the present invention;

FIGURE 6 is a partial sectional view showing manufacture of a washer of the present invention;

FIGURE 7 is a side elevational view showing a further embodiment of washer in accordance with the instant invention;

FIGURE 7A is a top plan view, partly broken away, of the lock washer of FIGURE 7;

FIGURE 8 is a sectional elevational view showing another modification of lock washer of the present invention;

FIGURE 8A is a top plan view of the lock washer of FIGURE 8;

FIGURE 9 is a side elevational view showing a further embodiment of lock washer in accordance with the instant invention;

FIGURE 9A is a top plan view of the washer of FIGURE 9;

FIGURE 10 is a side view showing the lock washer of FIGURES 8 and 8A in operative assembly;

FIGURE 11 is a sectional elevational view showing still another embodiment of lock washer constructed in accordance with the teachings of the instant invention; and

FIGURE 12 is a sectional elevational view showing still another lock-washer construction of the instant invention.

If a sheet metal strip **30**—as shown in FIGURE 1—which is provided on one side with incisions or cuts **31**, is subjected to a tensile load evenly distributed across the width of the strip at each end, the result will be that the elongation of the strip on that side which has the incisions will be greater than that on the other. Consequently the strip will be bent in the manner shown in FIGURE 1. If this effect is analogously applied to a fan-type split ring **35** having cuts **36**, the obvious result is that the ring will splay and open in the manner illustrated in FIGURE 2.

If now a nut is tightened on to the ring **40** of FIGURES 3A and 3D by clockwise rotation, then splaying and opening of the split ring can be prevented if the two cutting edges **41** and **42** at each end of the split fan-type ring are concentrically provided on only that part of the ring which has not been weakened by any incisions or cuts **43**. The primary effect of the biting edges **41** and **42** according to FIGURE 3A is that the upper portion of the ring will be slightly entrained when the nut is tightened—possibly with a slight tendency for the ring to close inwards on to the bolt, whereas the bottom biting edge holds the lower portion of the ring on the base. In order to ensure that the two biting edges **41** and **42** will be the first to bite, their elevation and strength are arranged to be greater than those of the fan-like teeth sections **43**. The two biting edges **41** and **42** should always take effect before the obliquely placed teeth **43**.

When the nut is tightened, forces P_1 will arise, as shown in FIGURE 3D, and these will impart a slight tendency to the open fan-section ring to contract in diameter. If the biting edges are radially located, there is a risk of the ring splaying outwards. This tendency is further increased when the nut bears down on the teeth and squeezes them flat. FIGURES 3B and 3E show how any tendency of the two ends to splay radially when the nut bears down on the teeth can best be prevented. Although the biting edges **45** and **46** in FIGURES 3B and 3E as such suppress the tendency of the ends to splay, they do not achieve the above described effect of the biting edges according to FIGURE 3A which produce a tendency for the diameter to contract.

FIGURES 3C and 3F show the correct and most serviceable way of providing the biting edges or ridges **51** and **52**. The force component P_1 has the effect, as already described, of counteracting the tendency of the ring to splay (i.e. increase its diameter). The force component P_2 prevents the ends of the locking ring **50** from moving radially outwards when the nut is tightened down on to the teeth. To ensure that the two components of force will co-operate, the biting edges or ridges are placed obliquely as shown in FIGURES 3C and 3F.

According to the invention the biting edges 54 and 55 of split ring 56, and 57 and 58 of split ring 59, as illustrated in FIGURES 4 and 5 are inclined in relation to each other in such a way as to include an angle (W), also see FIGURE 3, which opens towards the centre of the ring. As has been explained, the length of the biting edges is so contrived that their ends towards the centre of the ring are located at the point or only slightly beyond the point where the zone containing the locking tooth sections begins. Moreover, the biting projections are to be contrived in such a way that they will always be engaged before the teeth are engaged.

A convenient method of imparting to the biting edges a suitable shape, such as that shown in FIGURES 4 and 5 is by upsetting as between dies 60 and 61 in FIGURE 6. As has been mentioned, the biting edges must come into engagement before the teeth. It is irrelevant to the invention whether the biting edges are actually at the end of the annular strip or merely near its ends. However, they must become operative before the teeth take effect.

The illustrations also show that the biting edges or ridges merely extend across approximately half the width of the annular strip. It is also always necessary that the ridges should be inclined "in locking direction" to ensure that they will bite before the teeth become effective and hence counteract the tendency of the teeth to splay the ring.

In some circumstances it may be advisable to strengthen the material at the ends of the annular strip by a suitable upsetting process in order to improve the efficacy of the biting edges or ridges and also in order to relieve the teeth by limiting the pressure of the nut on the teeth when the nut has been pulled tight. The closed fan sections which can be produced only with considerable waste of material will not have overlapped teeth if the material constituting the teeth is first attenuated by an appropriate upsetting operation. In the case of teeth which by their spring elasticity are intended to produce the locking effect this would be a most undesirable feature. In the locking rings according to the invention a considerable amount of overlap is achieved without attenuation of the material and without subjecting the teeth to an upsetting process, because the obliquely placed teeth move into overlapping positions when the strip is bent together into a ring, the teeth retaining the full gauge of material. Moreover, it must be remembered that in the production of closed fan-section washers there is a loss of up to 80% in material, whereas the above described fan-section rings are produced without waste and without attenuation of the material forming the teeth. A saving in material of as much as 75% in the case of open rings already affords a very substantial economy.

The further advantage of the invention consists in that the device is not limited in its practical embodiment to a single convolution split ring. The locking ring may take the shape of a helical multi-convolution spring washer, especially when it is desired that major impact loads are to be sustained—for instance in railway permanent ways. A multi-convolution helical spring washer has the advantage that the spring deflection is spread over a greater distance and that an increase in the size or number of the teeth prevents the locking ring or its teeth from being excessively stressed and from fracturing.

FIGURE 11 shows a two-convolution helical washer with a larger contact face towards the base than towards the nut. Differences in the configuration of the several convolutions nearly always afford advantages. Normally, the contact face at the base will be larger than that at the nut. In order to be fully utilised, the lower convolution 21 has larger diameter than the upper convolution 23. The larger diameter considerably reduces the tendency to slip or of the diameter increasing due to the ring splaying. A different configuration of the two parts

of the ring will therefore always be advisable in cases in which one part has a larger contact face than the other. It will also suggest itself to design the two parts of the ring differently, for instance as follows in FIGURE 7: the lower portion 1 could be provided with outside peripheral teeth 2 and the upper portion 3 with internal peripheral teeth 4. In these drawings the biting edges or ridges are not shown. FIGURE 7 is a side view of the two-convolution ring, whereas FIGURE 7A is a plan view from above.

FIGURES 8, 8A and 10 illustrate a two-convolution toothed ring with a portion 7 having no teeth in a portion of material of thicker cross section. Locking rings in the form of a multi-convolution helix with a thicker untoothed portion are especially serviceable in cases where major shock loads must be sustained. In such locking rings, especially locking rings with one convolution having a larger external diameter, the danger of fracture when highly stressed is substantially less.

In the embodiments shown in FIGURES 9, 9A the lower helical convolution 14 has teeth 12 whereas the upper convolution 15 is toothless. The lower helical convolution 14 has a larger diameter than the upper convolution 15 of the locking ring. In the drawings it is assumed that the top of the ring is the side which will be in contact with the nut.

In the embodiment according to FIGURES 7 and 7A the bottom convolution 1 is provided with an outer zone of fan-like overlapping locking elements or teeth 2 whereas the upper convolution 3 of the helix is provided with a fan-like inner zone of sections which constitute locking elements or teeth 4. The object achieved by this arrangement is that the outer teeth can apply themselves to the supporting base with a considerable lever effect whereas the inside teeth are fully in contact with the hexagonal underside of the nut.

The embodiment in FIGURES 8 and 8A differs from the foregoing substantially in that the thickness of the material in the portions 5 and 7 having no teeth is very much greater than that of the teeth 6 and 8.

FIGURE 10 illustrates the manner in which a locking ring of the kind shown in FIGURES 8 and 8A is used, for instance on a bolt in a railway track.

In the embodiment shown in FIGURES 9 and 9A only the bottom convolution 14 of the helix is provided with sectioned or tooth-like locking elements 12, whereas the upper convolution 15 has no teeth. The biting edges or ridges are indicated at the end portions 13.

In order to secure a particularly powerful helical spring effect the unincised portion of the locking ring of FIGURES 9 and 9A is of thicker material than that portion which is formed with teeth 12, in the same way as in the embodiment shown in FIGURE 10. For the same reason the unincised portion 16 is substantially wider in the radial direction than the toothed portion. The inner diameter or internal radius Pi is the same in the case of both convolutions. The outer diameter R_1 of the toothed portion is larger than the outer diameter R_2 of the upper convolution in order to provide a better lever effect.

In the embodiment according to FIGURE 11 the teeth 22 which—as in FIGURE 9—are provided only in the bottom convolution 21 also project considerably beyond the outer periphery of the upper convolution 23. The object of this arrangement is to permit the external teeth to bear on a wider base with a greater lever arm, and hence to provide a particularly effective grip. On the other hand, the upper convolution, with its smaller external diameter is adapted to the dimensions of the nut in such manner that the periphery of the convolution will bear everywhere against the underface of the nut. The upper convolution 23 has a smaller internal diameter than the other convolution 21. There is no objection to this in an embodiment such as that in FIGURE 11 because the upper convolution 23 has no projecting locking elements. On the other hand, in cases in which the convolu-

tion adjacent the nut is provided with locking elements around its inner diameter, for instance in the manner of the embodiment shown in FIGURES 7, 7A or 8 and 8A, it is better that the inner diameter of the convolution adjacent the nut should not be smaller than the internal diameter of the convolution remote from the nut. The outer edge **24** of the non-incised portion of convolution **21** is not as thick as the thickness of the material formed with teeth **22**. In place of the overlapping tooth shape shown in the drawings the projecting locking elements may also have other shapes. Moreover, instead of using the preferred embodiment which comprises about 1¾ to 2 convolutions, longer and shorter helices may also be used. The forms of construction of the convolutions adjacent and remote from the nut may also be conversely arranged.

The embodiment of FIGURE 12 illustrates that the several convolutions of a lock washer of the present invention may be of different axial dimensions or thicknesses, which is advantageous under certain circumstances. Thus, the helical locking ring of FIGURE 12 may include a lower or bottom convolution **71**, and an upper or top convolution **73**, which for simplicity of illustration are shown as having teeth **72** on the outer periphery of the lower convolution only, and with the convolutions having the same internal diameter. However, it will be observed that the axial dimension, thickness or height of the lower convolution **71** is considerably greater than that of the upper convolution **73**.

From the foregoing, it is seen that the present invention provides a locking washer or ring construction which fully accomplishes its intended objects and is well adapted to meet practical conditions of manufacture, installation and use.

I claim:

1. A self-locking split washer comprising a ring having axially and radially extending surfaces, a gap, radial upstanding locking teeth in an annular zone on an axially extending surface of the ring for gripping the members between which the washer is tightened, a biting edge having side faces and outstanding from one radially extending surface of said ring on one side of said gap and displaced radially from said annular zone containing said teeth, and another biting edge having side faces outstanding from the opposite radially extending surface of said ring on the other side of said gap and displaced radially from said annular zone containing said teeth, each of said biting edges being inclined to a radius of the ring, the angle of inclination between said biting edges forming an acute angle opening towards the center of said ring, and the elevation of each of said biting edges being more than the elevation of said teeth, so that said members are gripped by the biting edges before being gripped by said teeth, and the side faces defining said biting edges being so formed that the forces acting on the biting edges during tightening of the washer tend to close said gap in the washer and so resist splaying of the washer.

2. A washer according to claim 1, wherein each side of the teeth forming said biting edges are formed so as to taper towards the center of said ring.

3. A washer according to claim 1, in which the thickness of the material of the ring below the biting edges is more than the thickness of the material in the other parts of the ring.

4. A washer according to claim 1, wherein the ring has a helical shape, said biting edges being provided at each end of the helix.

5. A washer according to claim 4, wherein the helix has more than one convolution, a part of said ring having said radial locking teeth near the inner edge of the ring, and a part of said ring having said teeth near the outer edge of the ring.

6. A washer according to claim 4, wherein the helix has more than one convolution, the internal and external diameters of the several convolutions being different.

7. A washer according to claim 4, wherein the helix has more than one convolution, the axial thickness of the several convolutions being different.

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