June 19, 1934. W. G. WILSON 1,963,573

METHOD OF MAKING LOCK WASHERS

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Fig. 1.

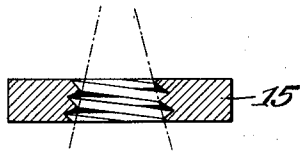


Fig. 2.

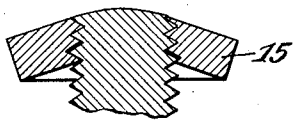


Fig. 3.

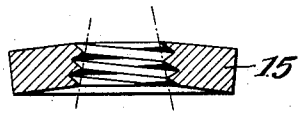


Fig. 4.

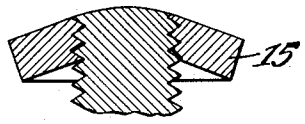


Fig. 5.

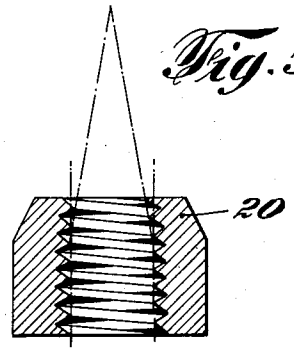


Fig. 6.

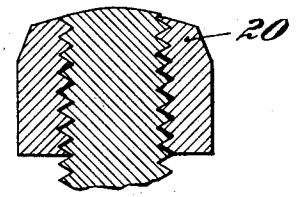


Fig. 7.

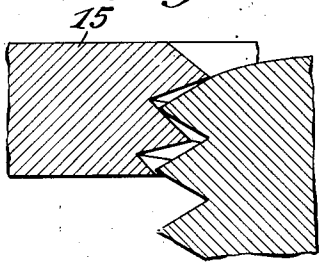
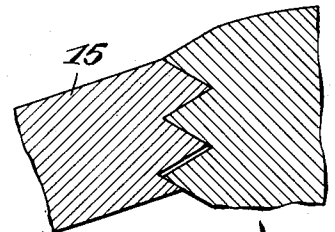


Fig. 8.



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Fig. 9.

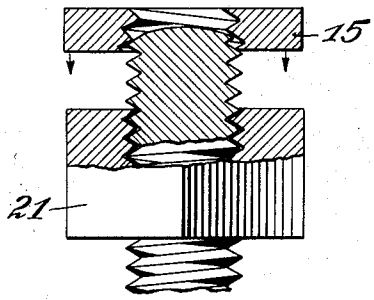


Fig. 10.

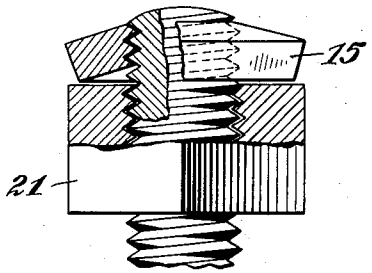


Fig. 11.

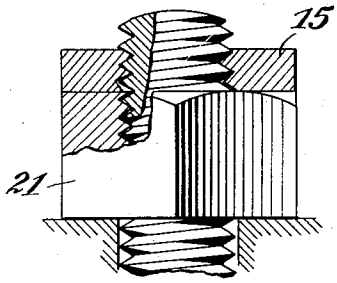


Fig. 12.

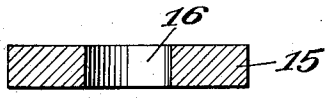


Fig. 13.

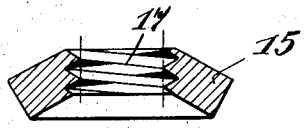
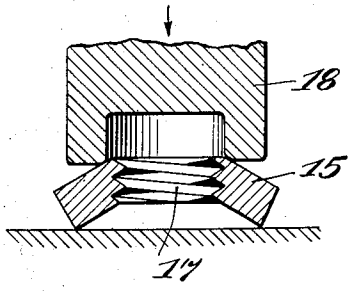


Fig. 14.



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UNITED STATES PATENT OFFICE

1,963,573

METHOD OF MAKING LOCK WASHERS

Wylie G. Wilson, Elizabeth, N. J.

Application May 21, 1931, Serial No. 538,965

7 Claims. (Cl. 10—86)

This invention relates to lock washers and constitutes a development of the invention covered in my U. S. Letters Patent No. 1,785,924, issued December 23, 1930. An object of the invention is to produce a lock washer of the general character set forth in my said Letters Patent, which will more effectively fit any one of a number of bolts with which it is intended to be used, notwithstanding slight commercial variations in the bolt diameters, this, of course, within reasonable limits; and also to produce a lock washer which, in its application to the bolt, will function to hold itself against rotation on the bolt, and also by its reaction with the bolt, on the one hand, and with the nut or other element to be locked on the bolt, on the other hand, will securely lock said nut or element in position.

In the accompanying drawings, in which I have illustrated useful forms of the invention:

Fig. 1 is a sectional view through a washer embodying my invention, made of metal and of proper size and proportions for the intended purposes.

Fig. 2 is a sectional view showing the washer of Fig. 1 when applied to a bolt.

Fig. 3 is a sectional view similar to Fig. 1, showing a modified form of the lock washer.

Fig. 4 is a sectional view showing the lock washer of Fig. 3 as applied on a bolt.

Fig. 5 is a sectional view illustrating still another modified form of the locking device.

Fig. 6 is a sectional view showing the locking device of Fig. 5 applied on a bolt.

Figs. 7 and 8 are sectional views with parts broken away showing the lock washer of Fig. 1 in different relative positions on a cooperating bolt.

Fig. 9 is an elevation with parts in section and parts broken away, of a bolt with a nut thereon, showing the lock washer of Fig. 1 in its initial application to the nut and bolt assembly.

Fig. 10 is an elevation showing the subject-matter of Fig. 9, but with the lock washer screwed down on the bolt, but still without contact between the lock washer and the underlying nut.

Fig. 11 is a sectional view of the subject-matter of Fig. 10, but with the lock washer turned down into reactive relation with the underlying nut.

Figs. 12, 13 and 14 illustrate a method of making the locking device shown in Fig. 3, Fig. 12 being a sectional view of a flat washer with a central unthreaded aperture.

Fig. 13 is a similar view showing the washer of Fig. 12 formed in cone shape, with the central aperture provided with a parallel thread.

Fig. 14 is a sectional view showing the parallel threaded taper washer of Fig. 13 ready to be acted upon by a former for reducing the conicity of the washer, and thereby to produce the lock washer of Fig. 3, in which the central aperture is a threaded taper hole.

Referring to the numerals on the drawings, a flat washer 15 with an unthreaded central aperture 16, as shown in Fig. 12, is by any suitable means given a cone form as shown in Fig. 13, and the central aperture thereof equipped with a parallel thread 17. This would constitute a lock washer of the type shown in my aforesaid Letters Patent. The washer is now reduced in conicity, as by the method suggested in Fig. 14, in which the base of the cone rests upon a flat surface, and pressure is applied by a former 18, which preferably contacts with the apex portion of the washer outside the maximum diameter of the washer thread, so as to minimize risk of distorting the thread by direct pressure of the former therein. The conicity of the washer is thus reduced so that it takes the form of Fig. 3. Along with the change in conicity there will have been a change in the shape of the central aperture, which, as is clear from Fig. 3, is now a taper hole, with its larger diameter towards the base of the washer cone, and its smallest diameter towards the apex thereof. Roughly speaking, the taper of the sides of the threaded hole in the flatted washer is proportional to change in conicity of the washer. I have found that an angle of 9° on each side of the center line gives good results.

Of course it will be understood that instead of flattening the washer from the Fig. 13 form to the form of Fig. 3, the operation of the former 18 may be carried to such an extent that the washer will be brought to the flat form of Fig. 1; but there will be the same sort of change as to the central aperture, that is to say, the washer will have a threaded taper hole.

Conversely if a flat washer be provided with a hole with a parallel thread and the washer be coned, the hole will become tapered and enlarged at one end, reducing somewhat at the other end. That is to say, the washer will now have a threaded taper hole.

A washer such as thus far described, is applied to a bolt whose nominal thread diameter is slightly less than the large diameter of the threaded taper hole, and slightly larger than the minimum diameter of the threaded taper hole. When such a washer is applied, as illustrated in Fig. 7, that is, with the larger end of the washer

opening presented to the bolt end, the bolt end enters the aperture freely enough so that the taper may be turned on the bolt by hand until there is resistance due to the taper of the washer's aperture. When this happens more force will have to be used in order to turn the washer further down on the bolt, and the result of such further advance of the washer on the bolt is to pull the nut over the end of the bolt, overcoming the resistance due to the diminishing diameter of the washer opening. Because of the washer-like form of the device, when the small diameter of the washer opening is expanded to permit the passage through it of the bolt, the washer, if it was initially flat as in Fig. 1, frequently becomes coned as in Fig. 2, or if it was originally somewhat coned as in Fig. 3, its conicity may be increased, as shown in Fig. 4. If such a change in the form of the washer takes place, and because of that change, the larger diameter of the washer opening contracts, and as a consequence the washer threads on the larger diameters, which were previously an easy fit on the bolt threads, now grip the bolt threads. The action is shown in Fig. 8, where the washer threads at the larger diameter of its opening have swung into closer engagement with the bolt threads.

If the washer be originally flat, as shown in Fig. 1, the resistance to expansion, sufficient to permit the washer threads to pass over the bolt threads so that the washer screws completely on to the bolt, is greater than it is if the washer be originally conical, as in Fig. 3. If the washer be originally flat, then the resistance area is much greater than if it be originally coned, and the greater the original conicity, the less the resistance area. In other words, for a washer of any given thickness and material, with a given threaded taper hole one end of which requires to be expanded before the washer can screw completely onto a bolt, broadly speaking, the greater the conicity of the washer the less the resistance to such expansion. Also for a given perfection of intimacy between the expanded thread in the washer and the cooperating thread on the bolt, a definite conicity of washer with its base contacting with the nut to be locked is capable of producing increased pressure between the apex thread on the washer and the bolt in almost direct proportion to the degree of conicity in the washer at the time when its base contacts with the underlying nut.

This statement is true, however, only if we disregard the effort required to rotate the washer after its base has contracted with the nut to be locked (or the flattening abutment if the washer itself is to act as a nut).

If the conicity be too great the resistance of the washer to rotation will reach the point where the wrench slips on the washer before maximum grip is obtained.

We thus provide a washer which is self-clamping on the bolt, which after it has brought to the condition in which it grips the bolt, can be turned further on the bolt by means of a wrench, but which will not turn of itself or without offering resistance.

I prefer to use the washer form of the device for many purposes, but obviously I may obtain good results by employing the form shown in Figs. 5 and 6, in which there is something more closely approximating an ordinary nut, with considerable axial dimension, but with the threaded taper hole. In order to adapt such a structure for the purposes of my invention it may be necessary to weaken the portions of the nut adjacent the smaller end of the nut opening, as indicated by the numeral 20 in Figs. 5 and 6. As shown, the nut has parallel threads through part of its length and the taper is provided at one end of the hole.

Whatever the form of the nut, the desired taper hole can be produced in a number of ways. It can be produced by tapping with a tapering tap such that both the root of the thread and the peak of the thread are taper, i. e., at an angle to the axis of the hole.

It can be produced by tapping with a tapering tap such that the root of the thread is parallel and the peak or apex of the thread forms a taper hole.

It can be produced by tapping with a parallel tap such that the apex of the threads form a hole less in diameter than the root of the thread on the bolt and then either running a taper reamer into the nut thus making a hole tapering all the way, or running in a parallel reamer which cuts out the apex of the thread for a portion of the length of the nut and leaves them untouched for the balance of the nut.

It can be produced by tapping with a parallel thread and then changing the conicity of the nut so as to make the hole embraced by the apex of the threads a taper hole.

If produced by the last mentioned means the washer may be originally flat and when coned to produce a taper hole the base of the cone will be at the opposite end of the hole to the large diameter of the hole.

It may be produced by reducing the conicity of an already coned washer. In this case the large diameter of the hole will be on the same side as the base of the cone.

Considering another phase of my invention, attention is called to the showing of Figs. 9, 10 and 11. Fig. 9 shows a lock washer like that illustrated in Fig. 1, screwed down on the end of the bolt to about the point where resistance to free turning is felt. By means of a wrench the lock washer is turned further on the bolt, whereby the washer is brought into the coned form as shown in Fig. 10, but still out of contact with underlying nut 21, which, in this case, is supposed to be the element whose position on the bolt is to be fixed by means of the lock washer. Further turning of the washer on the bolt brings the base of the washer cone finally into contact with the surface of the nut 21.

Attention is called to the fact that when the washer is flattened against an underlying nut the pressure is produced by a toggle effect, and as the angle of the toggle increases the effect diminishes.

As an example of the effect of absolute size upon the design of these washers when they are originally coned I may say that I have found, in practice, most excellent results from washers for ⅞" bolts with an original conicity of about fifteen degrees, but with ½" washers a conicity of five or ten degrees greater was necessary in order to produce results comparable in relative efficiency with those produced by the fifteen degrees on the ⅞" washer. The relative tightness of the small diameter portion of the taper thread is proportional, in each case, to the customary looseness of standard nuts on these size bolts.

We may broadly say that a conicity of less than 45 degrees is desirable in order to produce the most efficient combined locking effect of threaded taper hole and change of conicity in the screwed up position.

In practice the degree of original conicity varies

between about 35 degrees as a maximum, and nothing, with the probabilities lying between 35 degrees and five degrees, and the maximum probabilities lying between 30 degrees and five degrees in the case of washers which have a conical form before they are screwed onto the bolt.

If the screwing down of the washer be continued to the point where, as in Fig. 11, the washer is flattened, the grip of the washer threads at the lower end of the washer opening (which were originally the threads at the larger diameter of the taper hole) may be somewhat relaxed, but there will be a compensating increase of the grip of the threads at the upper end of the washer opening.

I have spoken of screwing the washer onto the bolt, and it will be understood that it will be square or hexagonal in plan, or otherwise formed so that a wrench may be applied for turning it on the bolt.

I claim:

1. The method of manufacturing lock washers which comprises forming a washer-like element in cone-shape with a threaded continuous walled hole therethrough, changing the conicity of the element while the wall of the hole is free from support other than that of integral structure and thereby giving the hole a taper from end to end with the circularity of the hole maintained.

2. The method of manufacturing lock washers which comprises forming a washer-like element in cone-shape with a central continuous walled hole therethrough having parallel threads, reducing the conicity of the element while the wall of the hole is free from support other than that of integral structure and thereby giving the hole a taper from end to end with the circularity of the hole maintained and with the large end of the hole towards the base of the cone.

3. The method of producing a threaded taper hole in a nut structure, which consists in producing a threaded cylindrical continuous walled hole in the nut, and then tilting the sides of the hole out of parallel, throughout the entire length of the hole, by applying pressure in an axial direction while the wall of the hole is free from support other than that of integral structure.

4. The method which consists in producing in a nut structure a threaded continuous walled hole of even diameter at all similar cross-axial sections, then deforming the structure while the wall of the hole is free from support other than that of integral structure by applying pressure in an axial direction to change the diameter throughout the entire length of the hole all the way around the hole.

5. The method of manufacturing lock washers which comprises forming a washer-like element with a threaded hole therethrough and coning the element while the wall of the hole is free from support other than that of integral structure, thereby producing a circular tapered hole.

6. The method which consists in producing in a nut structure a threaded continuous walled hole, and then deforming the structure while the wall of the hole is free from support other than that of integral structure by applying pressure in an axial direction to change the diameter of the threaded hole throughout its entire length.

7. The method which consists in producing in a nut structure a threaded hole, and then enlarging the hole for a portion of its length while the wall of the hole is free from support other than that of integral structure by applying axial pressure to deform the nut.

WYLIE G. WILSON.