

May 4, 1965

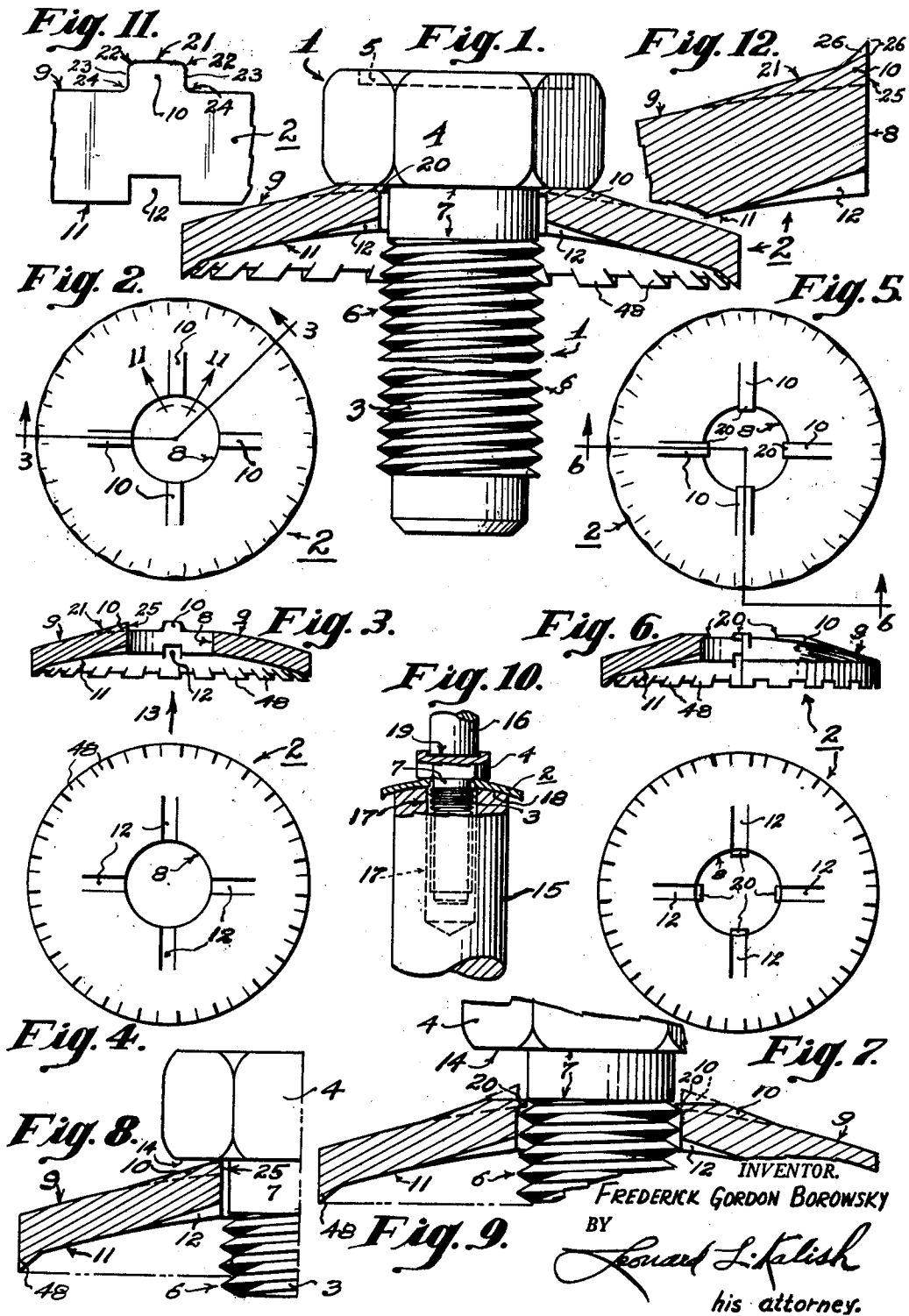
F. G. BOROWSKY

3,181,584

SCREW AND WASHER PRE-ASSEMBLY

Filed Aug. 21, 1959

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

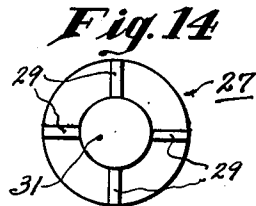
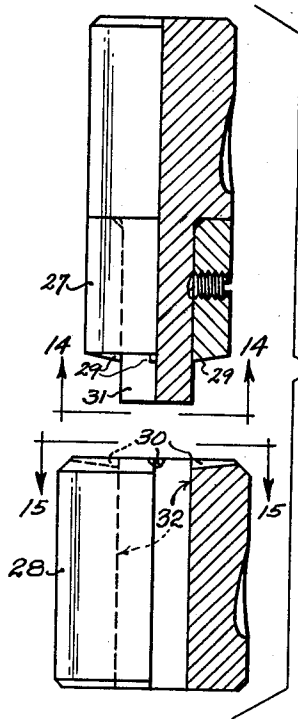


Fig. 13

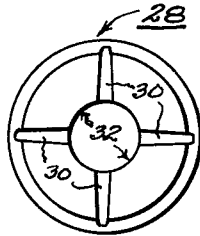


Fig. 15

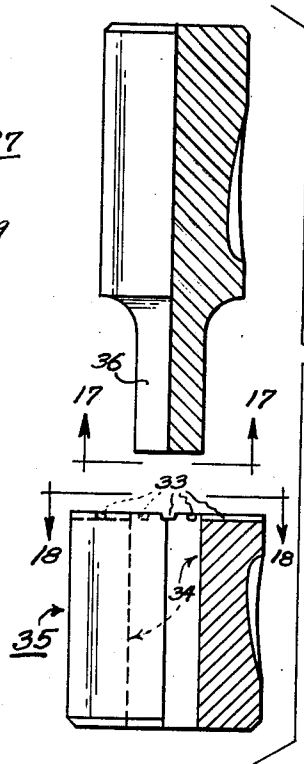


Fig. 16

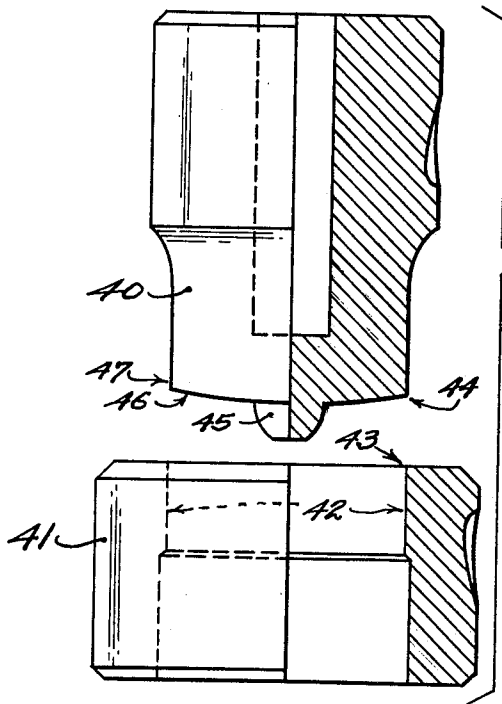


Fig. 19

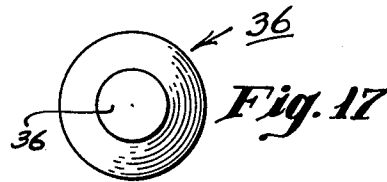


Fig. 17

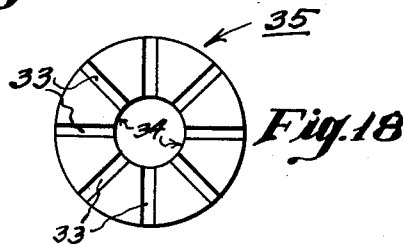


Fig. 18

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SCREW AND WASHER PRE-ASSEMBLY

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Fig. 20

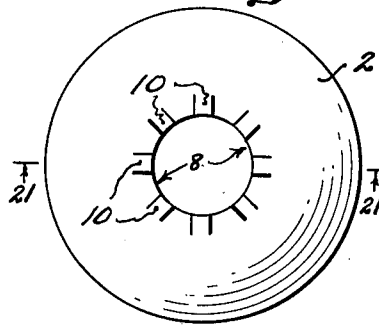


Fig. 21

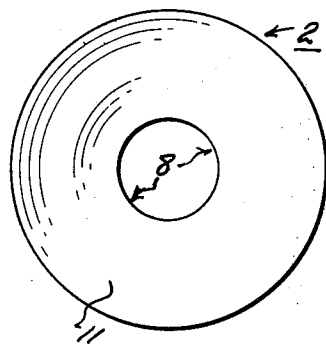


Fig. 22

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3,181,584

SCREW-AND-WASHER PRE-ASSEMBLY

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Filed Aug. 21, 1959, Ser. No. 835,227

2 Claims. (Cl. 151-37)

The present invention relates to a new and useful bolt-and-washer pre-assembly and method of making the same and to a new and useful washer construction for such pre-assembly.

When using washers beneath the heads of bolts (or screws) in assembly-line type or other type of mass-production of automobiles, appliances and other products, it has long been the practice to pre-assemble the washer with the bolt or screw in such a way as to retain the washer adjacent the head of the bolt or screw, so that the assembler or assembly-line worker is spared of the time-consuming operation of first putting a washer on the bolt or screw, before applying the bolt or screw to the machine parts to be secured to each other by such a bolt (or screw) and washer. Such pre-assembly also eliminates the possibility of error in the use of washers whose top-side and bottom-side are different, and which hence require special care and attention in the manual (or on-the-job) assembling or placing of the washer on the bolt, so as to make certain that the top side of the washer always faces to the bolt-head; as, for instance, when using dished washers.

Several different constructions in bolt-and-washer pre-assemblies and several different methods of making such pre-assemblies have been developed in the past, as shown by the following United States patents:

Olson, 1,788,735, issued Jan. 13, 1931, filed June 11, 1928
Vacher, 1,945,005, issued Jan. 30, 1934, filed Mar. 29, 1930

Crowthers, 2,113,425, issued Apr. 5, 1938, filed Oct. 23, 1937

Olson, 2,150,126, issued Mar. 7, 1939, filed Oct. 22, 1938
Hanneman, 2,152,591, issued Mar. 28, 1939, filed Feb. 17, 1937

Mitchell, 2,192,322, issued Mar. 5, 1940, filed Mar. 11, 1939

Olson, 2,227,464, issued Jan. 7, 1941, filed Nov. 2, 1938
Tomalis, 2,270,359, issued Jan. 20, 1942, filed Feb. 27, 1939

Hanneman, 2,297,957, issued Oct. 6, 1942, filed July 8, 1940

Poupitch, 2,424,208, issued July 15, 1947, filed Aug. 8, 1944

Crowthers, 2,537,575, issued Jan. 9, 1951, filed Sept. 25, 1944

Mitchell, 2,672,069, issued Mar. 16, 1954, filed May 21, 1952

Of the several methods of pre-assembly indicated by these patents, the one most widely used is the method which consists of first placing the washer on the unthreaded shank of the bolt-blank or screw-blank, adjacent the head thereof, and then "extruding" the thread on the shank by any of the conventional threading-rolling machines; whereby the convolution of the thread nearest the head serves to retain the washer, because the outer diameter of the thread is substantially greater than the original diameter of the unthreaded shank of the screw-blank or bolt-blank. This method of pre-assembly is the basis of Patents 2,113,425, 2,152,591, 2,297,957, 2,537,575 and others. By this method of pre-assembly, any of the frequently required heat-treatments or finishes of the bolt necessitates the application of the like-heat-treatment

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or finishing-process to the washer as well, because the thread could not effectively be rolled or extruded on the unthreaded shank of the screw-blank or bolt-blank after the bolt had been case-hardened or plated. Hence the case-hardening or other finish had to be applied to the bolt or screw after the washer had been assembled thereon and permanently secured thereon. This frequently made it necessary to forego the desired heat-treatment or finish of either the bolt or the washer or both, or to impart to them a heat-treatment or finish which was something other than the optimum for each and which hence represented a compromise in the final quality of either the bolt or the washer or both.

The pre-assembly method exemplified by Patent 1,788,733 consisted of cutting a special groove in the screw or bolt adjacent the head and then interrupting the inner periphery of the washer so as to form inwardly extending tongue-like members which could be bent outwardly in an axial direction so as to separate their ends more widely and then bent inwardly after they were placed in registration with the groove so as to bring their ends more closely together and to be fitted into the groove. This method of pre-assembly, however, is not only more costly both because of the extra cost of making the screw with the groove in it, but also because of the greater cost of making the washer. Furthermore, a washer with an interrupted inner periphery (as in Patent 1,788,733) is not suitable for many important uses where high screw-loading is required or where the hole in the work-piece through which the shank of the bolt first enters is made large so as to provide the necessary large working clearance for easy alignment of the parts to be fastened and where the head of the bolt or screw is comparatively small so that a washer having a continuous inner periphery (and generally also of substantial thickness) is required in order to insure an adequate thrust-bearing between bolt-head and work-piece.

The method of pre-assembly generally exemplified by Patents 1,945,005 and 2,227,464, also involves higher cost of manufacture, because in each it is necessary to provide a shank-portion (immediately adjacent the bolt-head) of a diameter substantially larger than the outer diameter of the thread, and this involves a more costly manufacture of the bolt-blank or screw-blank. Moreover, either the complete riveting-over or the flaring of the enlarged-diametered shank-portion as in Patent 1,945,005 or the partial riveting-over or "upsetting" of portions of the enlarged diametered shank-portion as in Patent 2,227,464, cannot be readily accomplished after the bolt or screw has been case-hardened. Moreover, the enlarged-diametered shank-portion immediately adjacent the head and having an axial dimension substantially greater than the thickness of the washer, may prevent the head of the bolt or screw from effecting the full load-bearing engagement between it and the washer and between the washer and the work-piece because the enlarged-diametered shank-portion may bear directly against the work-piece if the hole therein does not fully clear such enlarged-diametered shank-portion, and would thus prevent the transmission of the full loading through the washer.

One of the objects of the present invention is to provide a bolt-and-washer (or screw-and-washer) pre-assembly which will obviate the necessity of threading the bolt-blank (or screw-blank) after the washer has been placed thereon and which will obviate the need for any specially shaped and hence more costly screw-blank (or bolt-blank) and which will permit the use of a washer having an uninterrupted inner periphery and which will insure the transmission of the full screw-loading entirely through the washer and which will permit maintenance of the diameter of the screw-receiving hole in washer at the minimum, namely, at a diameter not substantially greater

than the outer diameter of the screw-thread, so that an oversized hole in the work-piece immediately adjacent the washer will be adequately bridged by the washer for the required screw-loading.

Another object of the present invention is to permit the roll-threading of the bolt or screw blank and the hardening or other heat treatment or the plating or finishing of the bolt or screw (prior to the pre-assembly) and to permit the separate and independent hardening, tempering or heat-treating or the plating or other finishing of the washer, before the bolt and washer are brought together for pre-assembly.

Thus, in many uses, either the bolt (or screw) or the washer (or both) are required to be either heat treated or provided with plating or some other special finish; but with the heat treatment, plating or finish of the bolt (or screw) on the one hand, and the heat treatment, plating or other finish of the washer, on the other hand, being different.

Moreover, sometimes the requirements of hardness and resiliency (or other qualities) due to the special construction and function (or use) of the washer, on the one hand, and the requirements of cold-flow of the bolt-stock (for "heading" operation and the thread-rolling operation) and requirements of the tensile strength and surface-hardness (or other qualities) of the finished bolt, on the other hand, may also make it necessary to use two substantially different kinds of materials for the bolt and for the washer, respectively. Thus, for instance, where the washer is required to be axially compressible and to have some spring-like resiliency, it must be made out of a steel having an appropriately high carbon content (and perhaps other qualities or composition) which will permit it to be quench-hardened and then drawn or tempered to give it the desired spring-like resiliency (or other final qualities). Likewise, where it is desired to thread the bolt by rolling or extrusion and yet to give it a high degree of surface-hardness or skin-hardness, in its final condition, the steel of which the bolt is made may have to have a carbon content lower than that of the washer-stock (and may be otherwise of a composition different from that of the washer-stock) so that it may have the cold-flow or other working qualities required for the rolling or extrusion of the thread hereon; with the desired surface-hardness or skin-hardness of the finished bolt thereafter imparted to it by what is commonly called "case-hardening".

By way of example, the requirement for a particular end-use (of the screw-and-washer pre-assembly) may be that the bolt or screw be case-hardened by heating to a specified temperature and by dipping into a specified case-hardening material and by quenching at a specified temperature, while the washer may be one which is not to be heat treated or may be one which requires heat treatment quite different from that of the bolt or screw as, for instance, heat treatment not of the case-hardening type but instead of the type which will impart to the washer a desired degree of spring-like qualities or what may be called "spring hardening", namely, first hardening and then "drawing" to spring-temper. When the requirements of heat treatment, plating or other "finish" and/or of the material of the bolt (or screw) and the washer are significantly different, then pre-assembly by the now conventional methods and constructions is unfeasible, impractical, too costly or requires a compromise in the heat-treatment, plating or other finish of the bolt (or screw), on the one hand, and the washer, on the other hand, and such compromise may result in either the bolt or the washer (or each) being heat treated or finished to something less than the optimum heat treatment or finish for the particular end-use.

Thus, where the construction or method of pre-assembly (as in some of the prior-art) requires a deformation, flowing or extrusion of the metal which cannot be practically effected after heat treatment, it becomes necessary to pre-assemble the bolt and the washer with each other and then

heat-treat them or otherwise finish them together as a pre-assembled combination of bolt and washer.

By way of example, the particular use to which the bolt-and-washer pre-assembly is to be put may require a $\frac{3}{8}$ " bolt with 24 threads per inch made of S.A.E. 1022 steel having a core-hardness (for instance) of between 26 and 38 degrees on Rockwell Scale C and case-hardened to a depth of the order of 0.003" to 0.007", and an axially compressible dished washer of $1\frac{1}{4}$ " diameter made of S.A.E. 1050 sheet-steel of a thickness of the order of 0.102" to 0.106" which is to be first quench-hardened and then tempered to a final hardness (for instance) of between 40 and 48 degrees on Rockwell Scale C. The case-hardening of the bolt requires heating to between 1650° and 1700° F. and immersion in or contact with the carbonizing material and the subsequent quenching in water, while the spring-tempering of the washer requires heating to 1575° and quenching in oil and the subsequent drawing to the final temper by heating to a temperature of the order of 600° F.

Furthermore, where washers are pre-assembled with unthreaded screw-blanks and the enlargement of the outer thread-diameter by the rolling of the thread on the stem of the bolt or screw is used to retain the washer on the bolt or screw adjacent the head thereof, it is either difficult or impossible to thread the stem close enough to the head for certain uses; particularly where the washer forming a part of the pre-assembly is something other than a plain flat washer, and more particularly where the washer is a washer having a significant amount of dishing or concavity or hollowness or is one having other axially deformed portions which are so constructed that when the washer is squeezed between the head of bolt and the work-piece, the dishing or axially deformed portions will be axially compressed or flattened out, so that the spring-like resiliency of such dishing or otherwise axially deformed portion of the washer will serve to resist the unscrewing or "backing off" of the screw or bolt (when in use) due to vibration or other effects which may tend to loosen the screw or bolt.

Another object of my present invention is to permit the roll-threading of the screw or bolt before it is pre-assembled with the washer, so that the thread may be extended closer to the head, and so that when such axially compressible washer is thereafter pre-assembled with the bolt or screw, the thread will extend to a point along the shank of the bolt or screw which is no farther away from the head thereof than the minimum or fully compressed axial dimension of the washer beneath the head of the bolt; thereby providing maximum threaded engagement between the bolt and the work-piece, particularly near the head of the bolt.

Moreover, the now widely used method may also make it necessary to operate the thread-rolling machines at less than their maximum efficiency, because they have to be operated in direct conjunction with the washer-feeding equipment and they must be dependent on the putting of the stems of the bolts through the washers, since such bolt with the washer thereon (but not secured thereto) cannot be set aside or stored before the thread-rolling operation because they would come apart. This is particularly important where with the most up-to-date method and equipment the forming of the bolt-blank or screw-blank out of the wire stock (namely the "heading" and cutting off) and the threading of the shank by rolling or extrusion, are performed as one more or less continuous operation and where the washer must therefore be fed to the combined heading and threading machine between the heading and cut-off stage and the threading stage.

Hence, another object of the present invention is to permit the more effective use of the costly threading equipment or the costly combined heading and threading equipment by permitting such equipment to be operated at maximum efficiency without the intrusion of the bolt and washer assembly operation.

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Another object of the present invention is to effect such post-threading pre-assembly without having to deform any part of the bolt or screw in order to effect a permanent retention of the washer thereon, as is done in some of the prior-art bolt-and-washer pre-assemblies.

Other objects of the present invention will appear more fully from the following description and the accompanying drawings.

In the accompanying drawings, in which like reference characters indicate like parts,

FIGURE 1 represents an elevational view, partly in section, of a bolt-and-washer pre-assembly representing one embodiment of my present invention; the bolt being partly broken away so as to shorten this figure.

FIGURE 2 represents a top plan view of the washer shown in FIGURE 1 (but on a smaller scale); this view showing the washer before the washer-retaining nibs have been formed or extended inwardly of the hole diameter.

FIGURE 3 represents a vertical cross-sectional view on line 3—3 of FIGURE 2.

FIGURE 4 represents a bottom plan view of the washer shown in FIGURES 2 and 3.

FIGURE 5 represents a top plan view of the washer shown in FIGURE 2, but after the washer-retaining nibs have been formed thereon by the deformation of the upwardly-extending ribs or projections around the periphery of the hole.

FIGURE 6 represents a vertical cross-sectional view on line 6—6 of FIGURE 5.

FIGURE 7 represents a bottom plan view of the washer shown in FIGURES 5 and 6.

FIGURE 8 represents a fragmentary cross-sectional view of the washer and bolt pre-assembly, before the nib-forming projections on the top surface of the washer (adjacent the hole therein) have been deformed to produce the inwardly extending retaining-nibs.

FIGURE 9 is a view similar to FIGURE 8 but after the upper ribs or projections have been deformed to form the inwardly extending washer-retaining nibs; and showing the washer in the position which it is capable of assuming farthest from the head of the bolt (after the formation of the retaining-nibs).

FIGURE 10 represents an elevational view, partly in section, of apparatus which may be used in the practice of my novel method of making the bolt-and-washer pre-assembly.

FIGURE 11 is an enlarged fragmentary elevational view on line 11—11 of FIGURE 2.

FIGURE 12 represents a fragmentary cross-sectional view of a washer (taken in the same plane as FIGURE 8 and the left half of FIGURE 3) showing a modified form of construction of the deformable rib or projection (10), prior to its deformation.

FIGURE 13 represents in elevational view a punch-and-die, partly in section, for punching the screw-receiving hole (8) and forming the ribs (10) shown in FIGURES 2, 3, 4, 8 and 11.

FIGURE 14 represents an end view on line 14—14 of FIGURE 13.

FIGURE 15 represents 15—15 of FIGURE 13.

FIGURE 16 represents an elevational view (partly in section) of the punch and die for punching the hole (8) and for forming the shorter radial projections (10) around the periphery of the hole of the washer shown in FIGURES 20, 21 and 22 or of the washer shown in FIGURES 23 and 24.

FIGURE 17 represents an end view of line 17—17 of FIGURE 16.

FIGURES 18 represents an end view on line 18—18 of FIGURE 16.

FIGURE 19 represents an elevational view of the punch-and-die, partly in section, for dishing and blanking out the washer shown in FIGURES 2, 3, 4 and 11, but without the teeth along their outer periphery as shown in these FIGURES, and for blanking out the washers shown

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in FIGURES 20, 21 and 22, in FIGURES 23 and 24, in FIGURES 26 and 27 and in FIGURES 28 and 28.

FIGURE 20 represents a top plan view of a dished washer similar to that shown in FIGURES 2, 3 and 4, but the shorter projections (10) around the hole (8), which are formed by the punch-and-die shown in FIGURES 16, 17 and 18 (rather than the punch-and-die shown in FIGURES 13, 14 and 15).

FIGURE 21 represents a vertical cross-sectional view of the washer shown in FIGURE 20, taken on line 21—21 of FIGURE 20.

FIGURE 22 represents a bottom plan view of the washer shown in FIGURE 20 and 21.

In the drawings, the bolt (or screw) and washer are designated as 1 and 2, respectively.

In the embodiments of my invention shown, the bolt or screw 1, having a shank 3, may have any suitable head, as, for instance, the hexagonal head 4—with or without the slight flat-bottomed depression or recess 5 in the top thereof. The screw-thread 6 may be formed on the stem 3 by any conventional (or other) method, as, for instance, by rolling the thread on the cylindrical stem of screw-blank or by cutting the thread by any suitable thread cutting tool or die. In the illustration of my invention shown in the drawings, the thread 6 is intended to be represented as a rolled thread whose thread-depth is distributed more or less equally inside and outside the diameter of the original blank or unthreaded stem of the screw-blank. Thus, in rolling the thread, no metal is removed to form the thread, but, instead, the metal is made to flow or is "extruded" from the space constituting the portion of the thread-groove which is inside the cylinder (defined by the original cylindrical surface of the unthreaded stem of the screw-blank) into the space occupied by that portion of the body of the thread itself which is outside such cylinder.

Irrespective of whether the thread 6 is formed by a rolling or by a cutting type of thread-forming operation, a portion 7 of the stem 3 immediately adjacent the head 4 is left unthreaded. The axial dimension of the unthreaded portion 7 is preferably more or less equal to the thickness of the metal of the washer 2 or more or less equal to the overall axial dimension of the washer in the zone beneath the head 4 of the bolt when the washer is fully compressed. However, the axial dimension of the unthreaded portion 7 may also be made less than or more than the amount just indicated, if the particular use for which the pre-assembly is intended, makes it preferable or desirable to have the unthreaded portion of a different dimension.

If the thread 6 is formed by rolling the thread into a cylindrical stem-blank of uniform diameter or without any reduced-diameter portion adjacent the head, then the diameter of the unthreaded portion 7 will be less than the outer thread-diameter by an amount approximately equal to the thread-depth (or its radius will be less than the radius of the outermost ridge of the body of the thread by an amount approximately equal to one half of the thread-depth).

If the thread 6 is to be formed by cutting, then the portion 7 must likewise be reduced to a diameter sufficiently less than the diameter of the original unthreaded or blank stem 3 (into which the thread is to be cut), either in or during the making of the screw-blank or by a diameter-reducing cutting or "turning" operation before, during or after the thread-cutting operation.

A circular screw-receiving hole 8 is formed in the washer 2. The diameter of the hole 8 is preferably just large enough to clear the outer diameter of the screw-thread 6, so that the pre-threaded stem 3 of the screw 1 may be put through the hole without difficulty or without such binding as would impede the assembly of the washer and pre-threaded bolt by automatic assembly apparatus or machine; the diameter of the hole 8 being kept down however to the minimum which will permit the pre-

threaded stem 3 of the screw or bolt 1 to be put through the hole 8 in the mass-production of the screw-and-washer assembly.

A suitable number (preferably not less than four, and in any event not less than three) of circumferentially distributed radial ribs or projections 10 are raised out of the upper face 9 of the washer 2, having their upper surfaces 21 tapered outwardly from the washer-surface 9 towards the hole 8, so that the greatest height of the rib or projection 10 (before its deformation indicated in FIGURES 1, 5, 6, 7, 9 and 10) is at its inner end 25 which lies generally in the cylindrical projection of the hole 8, and so that the height of the rib or projection 10 diminishes radially outwardly from its end 25.

The ribs 10 may be formed by pressing the washer (in any suitable stage of its making or manufacture in a punch-press) between two dies 27 and 28 (FIGURE 13)—one die (27) bearing against its face 11 and having groove-forming ribs 29 extending therefrom, corresponding to the grooves 12 (in its face 11) and the other die (28) bearing against its face 9 and having grooves 30 therein into which the metal from the face 9 of the washer may be pressed to form the ribs or projections 10—the groove-forming ribs 29 of the first-mentioned die 27 and the grooves 30 in the last-mentioned die 28 (to receive the ribs or projections 10) being in registration with each other.

The ribs 10 are formed in this manner preferably at the end of the stroke by which the hole 8 is made by the punch 31 and the hole 32 in the die 28.

The projections 10 may however be otherwise formed. Thus, they may be formed simultaneously with and incident to the punching of the hole 8 in the direction of the arrow 13, by providing suitable notches 33 along the periphery of the hole 34 in the surface of the die 35 supporting the surface 9 of the washer during the hole-punching stroke of the punch 36. Suitable projections 10, shown in FIGURES 20 and 21, may be thus raised out of the surface 9 of the washer 2 immediately adjacent such punched hole 8 therein (and simultaneously with the punching thereof). In drawing or raising the projections in this latter manner, the projections 10 (FIGURES 20 and 21) will have a comparatively shorter radial dimension than can be given them by the first mentioned method of forming the projections or ribs 10 (FIGURES 2, 3 and 4).

After the bolt 1 and/or washer 2 have been separately heat-treated or plated or have been otherwise separately treated to impart to them whatever "finish" as required by the intended end-use (or without any heat-treatment, plating or other finish, if none is required by the intended end-use), but in any event after the bolt has been threaded and after the ribs or other projections 10 have been raised out of the upper surface 9 of the washer 2, the threaded shank 3 of the bolt 1 is extended through the hole 8 of the washer 2 until the ribs or projections 10 are brought into contact with the bearing-face 14 of the head 4 of the bolt or screw 1 as shown in FIGURE 8. The so assembled washer and screw may then be placed between projection-deforming or projection squashing tools or members 15 and 16, respectively, in the manner indicated in FIGURE 10. However, the washer 2 may be first placed on the top of (or against) the anvil member 15 and the shank 3 of the bolt then extended through the hole 8 thereof (while the upper arbor-like member 16 is held out of the way) and the arbor member 16 then brought into contact with the head 4 of the screw or bolt.

The anvil-like tool or member 15 is provided with a stem-receiving hole, recess or clearance 17, into which the threaded stem 3 of the bolt or screw 1 may be fully extended. The diameter of the recess or hole 17 is slightly greater than the outer diameter of the threaded portion 6 of the stem 3, so that the stem 3 may freely enter the hole or recess 17. The upper bearing surface or face 18 of the anvil member 15 may be shaped to

conform to the face or surface 11 of the washer 2 as shown in FIGURE 10. In the embodiment shown in the drawings, the washer 2 is slightly dished either in the form of a very shallow cone or a spherical form of large radius (compared to the diameter or transverse dimension of the washer). Hence, the bearing or supporting surface 18 of the anvil-like member 15 may be shaped correspondingly either in the form of a shallow cone or in the form of a spherical surface of like radius, but convex, so as to provide an anvil-like seat or support for the underside or face 11 of the washer 2 immediately adjacent to the hole 8 therein and for a suitable distance radially outwardly therefrom. The arbor-like or hammer-like tool or member 16 has a head-engaging face or end 19 which conforms generally to the upper surface of the head 4 of the bolt or screw, so that when the face or end 19 of the arbor-like tool or member 16 is pressed against the head 4 of the bolt or screw 1, it will not deform the head.

The arbor-like or hammer-like tool or member 16 may be a cylindrical plunger, with a flat end to fit into the recesses 5 in the top of the head 4 of the bolt 1 (and to bear against the flat top of the bolt within such recess) when the bolt 1 and washer 2 are assembled with each other and the stem of the bolt has been inserted into the hole 17 of the anvil-like or die-like member 15 with the underside or surface 11 resting on the upper face 18 of the anvil 15. The arbor-like or punch-like tool 16 is brought against the head 4 of the bolt, in the manner indicated in FIGURES 5 and 10 and is forced there-against either by a press-like operation (as, for instance, in a punch-press or an arbor-like press) or is forced against the head by momentary hammer-blow or hammer-like impact of or imparted to the member 16. The pressure or impact of the member 16 against the top of the head 4 of the bolt 1 (while the washer 2 is firmly supported on the anvil 15, as indicated in FIGURE 10) may cause only the uppermost or highest points or zones of the ribs or projections 10 immediately adjacent the hole 8 to be deformed (as indicated in FIGURES 1, 9 and 10) because the height of the ribs or projections 10 gradually increases towards (and reaches the maximum at) the periphery of the hole 8. Thus the tops of these ribs or projections 10 are pressed down or flattened down or "squashed" or swaged. However, partly because the angle between the upper surface 21 of the rib or projection 10 and its innermost end 25 adjacent to (and lying in an axial projection of) the hole 8 is either somewhat less than 90° or in any event not appreciably more than 90° and presents a more or less sharp corner (viewed normal to a median radial plane in which the axis of the bolt and washer lies), this deformation, squashing or swaging of the tops of the ribs or projections 10 causes the metal thereof to flow radially inwardly to form the ribs 20 which extend radially inwardly of the hole 8 of the washer 2, to points which are at a radial distance from the bolt-axis substantially less than the radial distance (from the bolt-axis) of the outermost portions of the ridges of the screw-threads 6.

The radially inclined or tapered upper surfaces 21 of the ribs or projections 10, shown in FIGURES 1 to 12, are preferably slightly convex and the generally radial outer convex junctures 22 between the upper surfaces 21 thereof and the generally radial sides 23 thereof, and the generally radial inner concave junctures 24 between said sides 23 and the upper surface 9 of the washer 2 are preferably rounded or filleted; further to bias the flow of the metal of the ribs or projections 10 radially inwardly to form the ribs 20 (when the tops of the ribs or projections 10 are squashed or swaged in the manner indicated above).

The swaged ribs 20 retain the washer 2 in an assembled relationship to bolt 1 in the manner indicated in FIGURES 1 and 9.

Sufficient metal-flow is provided by the aforementioned squashing or swaging of the ribs or projections 10, so that (with their coplanar or non-spiral or non-helical disposition) the nibs 20 will be "non-threading," whereby the washer 2 is retained on the bolt 1 even against any tendency (which might otherwise obtain) of the washer becoming disassembled from the bolt (while the "pre-assembly" is being shipped or transferred in large numbers or "in bulk" in or to containers or bins) by the thread-engaging entry of the nibs 20 into the groove of the thread 6.

Any tendency which might otherwise exist for the radially inwardly extending nibs 10 to make a threaded entry into the screw-groove is minimized if not indeed eliminated by my construction, because the nibs 20 all lie in a single plane (at a right angle of the screw-axis). Thus, as the plurality of circumferentially distributed nibs 20 do not lie in a spiral or helix, they cannot readily thread themselves through the spiral or helical thread-groove.

Because only the radially innermost zones of "tops" of the radially tapered ribs or projections 10 need be squashed in order to form the washer-retaining nibs 20, the screw and washer may be pre-assembled (according to my invention) after the washer has been hardened or spring-tempered (by heat-treating) to any of the various degrees of hardness generally imparted to washers (including lockwashers) which are hardened for their intended use.

In the modified form of construction of the deformable rib or projection shown in FIGURE 12, the rib 10 may be formed by means of the dies 27 and 28 (shown in FIGURES 13, 14 and 15) in the same manner as hereinbefore indicated, but with slight notches provided at the inner end of grooves 30 of die 28 so that when the hole 8 is punched out projections 26 will be drawn beyond the ribs 10. By this means, the innermost ends of the members 10 are made higher and so provided with additional metal for flowing radially inwardly when axial pressure is applied thereto.

After the hole 8 in the washer has first been formed in the sheet stock either with the projection 10 shown in FIGURES 2, 3, 4 and 8 or with the projections 10 shown in FIGURES 20, 21 and 22, the dishing of the washer is preferably effected simultaneously with the blanking out of the washer from the original strip of sheet-stock, as, for instance, by means of a punch 40 and die 41 shown in FIGURE 19. The die 41 has in it the die-opening or hole 42 against whose upper edge 43 the sheet metal is sheared by the corresponding annular edge 44 of the punch 40. The tapered or convex pin-like member or projection 45 in the leading end of the punch 40 enters the previously formed hole 8, so as to "pilot" the strip of sheet-stock (out of which the washer is to be blanked by the punch and die 40 and 41) so that the outer periphery of the washer will be in proper spaced relationship to the hole 8 thereof. By making the face 46 of the punch 40 convex and of suitable vertical dimension and shape, the sheet metal around the hole 8 is first dished to the desired amount and shape before the washer is sheared from the main body of the strip of sheet-stock.

By providing circumferentially distributed notches in the outer cylindrical surface 47 of the punch 40 immediately adjacent to and extending into the face 46 thereof, teeth 48 (shown in FIGURES 1, 3, 4, 6, 7, 8 and 9) may be drawn axially along the periphery of the washer, in a manner similar to the drawing of the projections 10 shown in FIGURES 20 and 21. Such teeth (48) may also be formed along the outer periphery of the washer shown in FIGURES 20 to 22, inclusive. The teeth 48 serve as locking means to resist any unintended loosening of the bolt or screw when it is finally tightened in place.

When the ribs or projections 10 face the bearing-face 14 of the head 4 of the screw or bolt, as in the illustrations in FIGURES 1 to 12 and 20 to 22, they also serve

as locking means to resist the loosening of the bolt or screw after it has been finally tightened in place. If the projections 10 are in the form of ribs of substantial radial extent, as for instance the ribs shown in FIGURES 1 to 12, inclusive, then portions of the ribs may remain after they have been squashed to form the washer-retaining nibs 20, as indicated in FIGURES 1, 5, 6, 7, 9 and 10; so that when the bolt-and-washer pre-assembly is finally tightened in place (on the parts to be secured thereby) the bearing-face 14 of the head 4 will bear against the more or less flattened or squashed ribs 10. Similar locking may also be achieved by the shorter projections 10 shown in FIGURES 20 to 22, although the squashing of these projections to form the washer-retaining nibs may be more complete than in the case of the ribs 10 shown in FIGURES 1 to 12, inclusive.

Having described and shown an embodiment of my invention, I claim:

1. A bolt-and-washer pre-assembly including two members, namely, a pre-threaded separately heat-hardened steel bolt having a head whose bearing-face is generally normal to its screw-axis and having a portion of its stem adjacent its head unthreaded and of a diameter substantially less than the outer thread-diameter thereof and forming an annular groove-like portion between the head and the threaded portion of the stem, and a pre-dished stamped sheet-steel washer concave on one side and convex on its other side, disposed on the aforementioned unthreaded portion of the stem adjacent the head, with its convex side facing the bearing-face of the head of the bolt and with its concave side facing the threaded portion of the stem of the bolt, at least one of said members having a surface-altering pre-assembly-finish absent from the other member, the body of said washer including an annular portion of unbroken continuity and having a generally uniform wall-thickness throughout the major portion of its area and its overall axial dimension being substantially greater than in its aforementioned wall-thickness, said washer having an uninterrupted and substantially circular screw-receiving hole of a diameter generally the same as the outer thread-diameter of the bolt plus only such working clearance as would be sufficient to permit the threaded portion of the stem of the bolt to be passed through the hole except for the retaining nibs referred to hereinbelow, said washer having a plurality of circumferentially distributed co-planar swaged washer-retaining assembly-nibs around and projecting inwardly of said hole on the convex side thereof, swaged by pressing against the bearing-face of the head of the bolt, originally axially upstanding projections extending from the convex side of the washer immediately adjacent said hole, said swaged nibs extending radially inwardly from the hole into the groove-like unthreaded portion of the stem of the bolt adjacent the head thereof to points which are at radial distances from the screw-axis thereof substantially less than the radial distance of the outermost ridge of the screw-thread from the screw-axis, the radial dimension of said nibs being not greater than the radial depth of the screw-thread and the axial dimension of said nibs being substantially less than the wall-thickness of the washer and the common plane of said nibs being generally normal to said screw-axis, and the radially innermost portions of said nibs being directly adjacent the bearing-face of the head when it bears against the washer, the end of the hole in the washer at the concave side thereof being devoid of said nibs and the axial length of the aforementioned untreaded portion of the stem being substantially less than the over-all axial distance between the top and bottom of the dished washer.

2. A bolt-and-washer pre-assembly including a pre-threaded and separately heat-hardened steel bolt having a head whose bearing-face is generally normal to its screw-axis and having a portion of its stem adjacent its head unthreaded and of a diameter substantially less than the outer thread-diameter and forming an annular groove-

like portion between the head and the threaded portion of the stem, and a separately pre-hardened axially compressible stamped sheet-steel spring-washer disposed on the aforementioned unthreaded portion of the stem adjacent the head of the bolt, the body of said washer including an annular portion of unbroken continuity and having a generally uniform wall-thickness throughout the major portion of its area and its overall axial dimension in its uncompressed condition being substantially greater than in its fully compressed condition and having a generally uninterrupted circular screw-receiving hole of a diameter generally the same as the outer thread-diameter of the bolt plus such working clearance as would be sufficient to permit the threaded portion of the stem of the bolt to be passed through the hole except for the retaining nibs referred to hereinafter, said washer having a plurality of circumferentially distributed co-planar swaged washer-retaining assembly-nibs around and projecting inwardly of said hole on the side of the washer facing the head of the bolt, swaged by pressing against the bearing-face of the head of the bolt originally axially upstanding projections extending from the side of the washer facing the head, immediately adjacent said hole, said swaged nibs extending radially inwardly from the hole into the unthreaded groove-like portion of the stem of the bolt adjacent the head thereof to points which are at radial distances from said screw-axis substantially less than the radial distance of the outermost ridge of the screw-thread from said screw-axis, the radial dimension of said nibs being not greater than the radial depth of the screw-thread and the axial dimension of said nibs being substantially less than the wall-thickness of the washer and the common plane of said nibs being generally normal to said screw-axis, the end of the hole in the washer at its side facing toward the screw-thread being devoid of said nibs and the radially innermost portions of said nibs being di-

rectly adjacent the bearing-face of the head when it bears against the washer in its compressed condition, and the axial length of the aforementioned unthreaded portion of the stem being substantially less than the overall axial dimension of the washer in its uncompressed condition.

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