

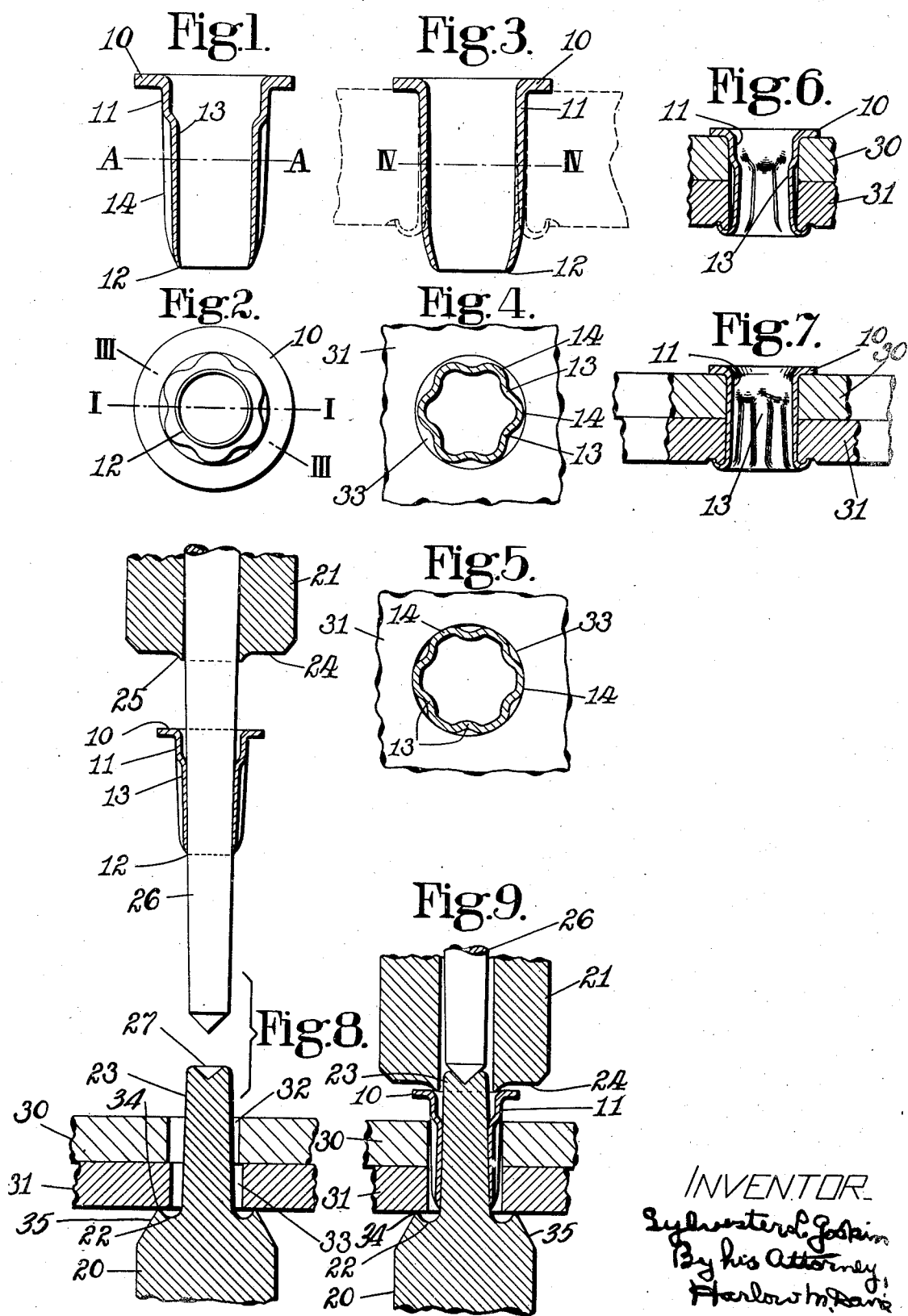
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EYELET

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EYELET

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This invention relates to eyelets and to certain problems encountered in setting them in hard materials as distinguished from materials that would be stretched by inserting tight-fitting eyelets therein or by expanding eyelets in process of being inserted therein. The expression "hard materials" as used herein contemplates metals such as iron, steel, bronze and brass, and the harder kinds of electrical insulating substances such as "hard rubber", "bakelite", and compressed fibre. The expression is not intended to include readily stretchable materials such as leather, textile fabrics or those grades of rubber or rubber compounds that have the property of stretching. Nevertheless, it will be apparent that eyelets of the type herein illustrated and described may be useful also in many readily stretchable materials, although they have special advantages and special utility with respect to certain problems encountered in materials that will not be stretched by them.

In certain electrical work, for example radio apparatus and distributors in ignition apparatus for internal combustion engines, satisfactory operation requires permanently tight connections between parts made separately but intended to be rigidly related when assembled. To cite a specific example in which eyelets of the type contemplated by the present invention and herein illustrated have solved such a problem after eyelets having circular barrels have been tried and have failed to do so, the angularly adjustably support for the make-and-break contact points of the primary circuit interrupter in one well-known distributor for internal combustion engines comprises a plate of hard insulating material mounted on a plate of metal and affixed to the latter plate by a plurality of fasteners that extend through both plates. The contact points of the interrupter are mounted respectively on these plates. Consequently, to insure positive control of the air-gap when the contact points are separated, it is necessary to eliminate relative edgewise movement of the two plates thus connected.

To avoid failure of the fasteners to enter the holes in the articles of work, particularly when insertion of the fasteners is to be performed by machinery, the leading ends of the fasteners must be smaller than the holes provided for the fasteners. Even if the fasteners taper toward their leading ends they require expanding to fill the holes after the leading ends have entered. When it was attempted to secure the plates with eyelets having circular barrels suitably tapered to

insure insertion, the barrels did not fill the holes, notwithstanding the fact that tapered mandrels were used to expand them in the holes. On the other hand, when eyelets having circular tapered barrels slightly larger at their larger ends than the holes were used, the larger ends of the barrels did not enter the holes but were merely crushed axially without sufficient protrusion of their smaller ends to provide for clenching.

The conditions encountered in the use of rivets are equally adverse, if not more so in some respects. For example, gang riveting is hopelessly beyond the range of possibilities when close spacing of the rivets is necessary or where small dimensional discrepancies are of moment. Even when rivets are inserted one at a time by machines they must be smaller than the holes, and relatively heavy riveting pressures are necessary to clench them so tightly as to prevent edgewise creeping of the connected parts.

With these conditions in view, an object of the present invention is to provide an improved type of eyelet that may be inserted in hard materials by an automatic machine and that will not be collapsed or crushed axially if it fits tightly the wall of the eyelet-receiving hole, and that may be rendered permanently tight if its barrel is initially not quite large enough to fill the hole.

To this end the invention provides an eyelet of ductile metal the barrel of which is provided with a flange at one end, a circular portion at the other end, and one or more longitudinally extending corrugations. As herein illustrated, the unflanged end is tapered to facilitate insertion of the barrel into an eyelet-receiving hole.

The corrugations serve several purposes. For example, if the corrugated portion is initially so large as to fit tightly in the eyelet-receiving hole, the corrugations not only stiffen the barrel against stresses that tend to crush it axially, but they also provide for slight radial contraction if that be necessary to insert the barrel. On the other hand, if the corrugated portion of the barrel is initially not quite large enough to fill the hole, it may be readily dilated to fill the hole and rendered permanently tight therein by deforming the corrugations during or after insertion.

It is preferable, with regard to stripping the eyelet from the corrugated eyelet-forming punch and die, to impart a slight taper to the corrugated portion of the barrel, but the degree of taper here may be very slight compared with that at the unflanged end of the barrel.

In practice, permanent tightness of an eyelet having the above-described characteristics, in

hard substances such as metal and other non-elastic materials, may be readily brought about by forcing a tapered tool of circular cross-section into the barrel far enough to compress and deform the corrugations. If the barrel is initially slightly smaller than the hole occupied thereby, the radial force applied by the tapered tool will dilate the barrel until dilation of the outer corrugations is arrested by the wall of the hole. Further movement of the tapered tool into the barrel will put both the inner corrugations and the outer corrugations under compression, since no further dilation of the outer corrugations is possible. Under these conditions some of the metal of the inner corrugations will be forced to flow into the outer corrugations, thus increasing the circumferential magnitude of the latter. Then, when the dilating force is removed, the barrel will not contract but will remain permanently tight in relation to the wall of the hole.

This permanence of tightness appears to be due to the fact that the final flowing of the metal of the barrel is produced by compression. Whether that is the correct explanation or not, the fact remains that the corrugations provide surplus metal and spaces into which it can flow under compression. The logical explanation, based on apparent conditions and proven results, is that when the outer diameter of the barrel is being increased by the dilating force the metal of the barrel undergoes a slight stretching which puts it in a state of tension, but when dilation of the outer corrugations is arrested by the wall of the hole further dilation of the inner corrugations not only eliminates the state of tension but thereafter puts the corrugations into a state of compression.

Thus, when two or more layers or plates of hard material are connected by corrugated eyelets that have been dilated and compressed between hard annular surfaces, they are positively maintained against relative edgewise creeping. This is so irrespective of the pressure with which the layers are maintained one against another by clenching the eyelets, since the dilation and the compression referred to take effect on the walls of the eyelet-receiving holes rather than on the outer surfaces of the connected layers. Moreover, since the individual corrugations of an eyelet are capable of unequal and dissimilar deformation, an eyelet having such characteristics will counteract discrepancies of small magnitude in the shapes and sizes of the eyelet-receiving holes and slight errors of register of the holes in superposed layers or plates of sheet material.

While the above-described effects are being produced the smaller end of the barrel may be clenched. As herein illustrated, the tapered tool for dilating and compressing the corrugations is provided with an annular surface for upsetting the smaller end of the barrel and producing a roll-clench.

The initial circularity of the smaller end of the eyelet-barrel not only facilitates insertion of the eyelet but also facilitates the upsetting and clenching of that end, particularly when, as herein shown, it is clenched in circular form. Moreover, the initial circularity at the end mentioned avoids splitting that end into segments when forming a roll-clench therewith.

Referring to the accompanying drawing,

Fig. 1 is a longitudinal section of an eyelet embodying the present invention, the plane of the section being indicated by line I—I of Fig. 2;

Fig. 2 is an end elevation of the eyelet as viewed from the smaller end of the barrel;

Fig. 3 is a longitudinal section of the eyelet in the plane indicated by line III—III of Fig. 2 but includes broken lines to illustrate the result of dilating the barrel and imparting a roll-clench to the smaller end thereof;

Fig. 4 is a cross-section of the barrel in its initial condition (see line IV—IV of Fig. 3) and occupying a circular hole in an article of work;

Fig. 5 is a view similar to Fig. 4 except that the barrel has been dilated to fill the hole and the corrugations thereof have been compressed and deformed sufficiently to maintain the ultimate degree of dilation;

Figs. 6 and 7 are sectional views corresponding to Figs. 1 and 3, respectively, except that they illustrate an eyelet as clenched and dilated in an article of work comprising two superposed layers or plates of hard sheet material;

Fig. 8 is a longitudinal sectional view including co-operative eyelet-setting tools, an eyelet as shown in Fig. 1 on the upper tool, and two layers or plates of hard materials lying on the lower tool in position to receive the eyelet; and

Fig. 9 is a view similar to Fig. 3 except that the eyelet has been inserted into the layers of work and is about to be upset, clenched and further dilated to fill the holes in the layers.

The illustrated eyelet comprises an unscored barrel that tapers from end to end and a flange 10 at the larger end thereof. The portion 11 of the barrel is circular and the smaller end 12 is also circular, but the greater part of the barrel between the portion 11 and the end 12 is provided with a circular series of longitudinally extending corrugations shown best in Fig. 4. The corrugated form is developed in the manufacture of the eyelet by making the barrel initially circular in cross-section throughout its entire length and thereafter indenting a circular series of internal arcuate corrugations 13, six in the illustrated example, thereby producing also a corresponding circular series of external arcuate corrugations 14. Toward the smaller end 12 of the barrel, the internal corrugations 13 and the external corrugations 14 merge gradually one into another, the original circularity of the smaller end 12 being thus preserved (see Fig. 2). This leaves the metal at the end 12 softer and more ductile than the metal in the corrugations. Both the internal corrugations 13 and the external corrugations 14 converge slightly toward the end 12, the external taper of the barrel being greater than the internal taper adjacent to that end. The metal of the barrel diminishes gradually in thickness from the flange 10 to the smaller end 12 in consequence of being drawn from the center of the area bounded by the rim of the flange.

For certain uses in which considerable strength is required, it is preferable to make the eyelets of brass having only a moderate degree of ductility. Consequently, as a result of indenting the corrugations 13, the barrel undergoes a hardening process between the circular portion 11 and the circular end 12 but little or no hardening at the latter. Therefore, since the end 12 remains relatively soft and ductile after the corrugations have been formed, it is the better adapted to be upset and clenched without being split into segments. Moreover, since the corrugations do not extend to the end 12, the latter may be upset and clenched in circular form without undergoing any change in cross-sectional shape.

Setting tools of the type illustrated in Figs. 8

and 9 have been found to be entirely satisfactory for upsetting, clenching and dilating eyelets of the type herein illustrated, and are being used commercially in gangs with satisfactory results.

Preferably, the lower tool 20 is stationary and supports the work while the upper tool 21 is reciprocated up and down to transfer eyelets from a raceway and insert them into the work. The lower tool is provided with an annular upsetting surface 22 formed to impart a circular roll-clench to the end 12 of an eyelet (see Figs. 3, 6 and 7). This tool is also provided with a central tapering pilot portion 23 of circular cross-section, the upper end of which is slightly smaller than the opening in the end 12 of the eyelet but the lower end of which is larger than this opening. Consequently, although the upper end of the pilot portion may enter the barrel of an eyelet without encountering any resistance, the end 12 of the barrel must undergo gradual expansion or dilation while traversing about two-thirds of the length of the pilot portion, and will thereafter be rolled back and clenched by the upsetting surface 22 without being split or divided into segments.

The upper tool 21 is provided with an annular seat or pressure-applying surface 24 and with an annular lip or flange 25 protruding therefrom. The lip 25 is adapted to enter the opening in the flange 10 but its outer surface embodies an abrupt taper, the base of the lip having a diameter slightly larger than that of the opening in the flange. Consequently, the lip 25 will dilate the hole in the flange 10 when the final clenching pressure is applied, and if the circular portion 11 is not as large as the hole 32 it will partake of the dilation until it is arrested by the wall of the hole or until the surface 24 of the tool engages the flange 10, as the case may be.

The upper tool 21 is further provided with a central spring-pressed spindle 26 of well-known form and arrangement to detach eyelets one by one from a raceway and to support them frictionally, as shown in Fig. 8, while they are being transferred to the lower tool 20. Consistently with common practice, the spindle 26 embodies a long gradual taper and its lower end is shaped to conform to a conical cavity 27 formed in the upper end of the pilot portion 23. The lower end of the spindle is thus centered by the cavity 27 so that the eyelet may pass from the spindle 26 to the pilot portion 23 without encountering any obstruction at the joint.

Fig. 8 includes fragments of two layers or plates of hard sheet material such, for example, as an element 30 of metal and an element 31 of fibre or similar hard insulating material. In the electrical distributors hereinbefore referred to, a thick sheet-metal plate corresponding to the element 30 is provided with a plate of insulating material corresponding to the element 31, the two plates being connected by five eyelets of the type herein illustrated. These eyelets, the centers of which are about three-eighths of an inch apart, are all inserted and clenched simultaneously by a machine in which the inserting tools are operated in gang relation. The eyelet-receiving holes 32 and 33 previously formed in the elements 30 and 31, respectively, are placed over the several pilots 23 of the ganged tools 20. Since the pilots are smaller than the holes, the holes in one plate may, and commonly do, lie initially out of alignment with those in the other plate, as represented in Fig. 8. While there is no purpose in this initial misalignment of the holes, it is illustrated be-

cause it is a condition that must be reckoned with.

In the operation of the machine, each spindle 26 picks an eyelet from a raceway as the tool 21 descends, the eyelet being thus positioned on the spindle as shown in Fig. 8. As the barrel of the eyelet passes first through the upper plate 30 and thereafter through the lower plate 31 its work-engaging corrugations 14 cause whatever edge-wise shifting of the plates may be necessary or possible to correct the alignment of the holes. As the pilot portion 23 progresses through the barrel of the eyelet it first dilates the smaller end 12 thereof and continues the progress of the dilation along the internal corrugations 13 to a point at or in the vicinity of the broken line A—A in Fig. 1. The effect of this dilation of the internal or indented corrugations 13 is transmitted to the work-engaging corrugations 14 with the results represented by dotted lines in Fig. 3 and by solid lines in Fig. 5.

When dilation of the external corrugations is arrested by the walls of the holes 32 and 33, further progress of the pilot 23 into or through the barrel of the eyelet will nevertheless continue to dilate the internal corrugations 13 and will thereby force some of the metal of the internal corrugations to flow into a circular band of limited diameter to which the wall of the hole stands as a matrix, with the result represented in Fig. 5. The external corrugations 14 have initially a short radius of curvature (see Fig. 4) but when the internal corrugations are forced into the spaces between the external corrugations the latter are spread open or deformed more or less as represented in Fig. 5. These changes of form are the results of radial forces brought to bear against the crowns of the internal corrugations 13 and tending to crowd the internal corrugations into the spaces between the external corrugations. Consequently, the process of deformation sets up a state of circumferential compression in addition to the pressure with which the external corrugations are forced against the wall of the hole. Certainly, under these conditions the metal of the barrel is not in a state of circumferential tension. It is therefore assumed that the permanent "set" or tightness of the barrel against the wall of the hole after the dilating force is removed is due to the circumferential compression to which the metal is subjected during the process of deformation.

Eyelets having the characteristics hereinbefore described, when set with tools of the character described, will counteract discrepancies of small magnitude in the shape and sizes of the eyelet-receiving holes. For example, if the hole in one of the eyelet-receiving elements is slightly larger or smaller than the corresponding hole in the other element, or is slightly eccentric thereto, the effective forces will cause greater dilation and deformation of the less constrained portions than of portions more constrained. Consequently, the dilated and deformed barrel will fit tightly in both holes. This is made possible by the individuality of the corrugations and by the spaces that provide for the flow of metal from the points of greater constraint toward the points of less constraint. At the point where dilation is first arrested, dilation at that point is followed by deformation of the corrugations while dilation may continue at other points.

Again, when each of the plates 30 and 31 is provided with a plurality of eyelet-receiving holes, one or more holes in one of them may not register exactly with the corresponding holes in 150

the other. Here also, the individuality of the corrugations with respect to dilation and distortion will counteract the non-alinement of the walls of the holes sufficiently to prevent all relative creeping of the connected plates.

As illustrated in Figs. 8 and 9, the clenching tool 20 is provided with an acute circular edge 34 at the intersection of the upsetting surface 22 and a frusto-conical outer surface 35. In practice, the acute edge 34, when brought to bear against certain materials not too hard or brittle, for example, compressed fibre used for electrical insulation, will indent such materials and form annular grooves or depressions into which the clenched ends of the eyelet barrels will be embedded as illustrated in Figs. 6 and 7. One advantage of such a groove is that it reduces the magnitude of protrusion of a roll-clench from the surface of the work in which the groove is formed. Another is that it avoids flattening a roll-clench. Again, if burrs are formed on the clenched end of an eyelet they will be buried in the groove.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An eyelet of ductile metal the barrel of which is provided with a flange at one end, a circular portion at the other end, and a circular series of longitudinally extending work-engaging corrugations.
2. An eyelet of ductile metal the barrel of which is provided with a flange at one end, a circular tapering portion at the other end, and a circular series of work-engaging corrugations that converge toward said circular tapering portion.
3. An eyelet of ductile metal the barrel of which has ends of different diameters, is circular at its smaller end and is provided with a flange at its other end and with a circular series of work-engaging corrugations that converge toward and merge gradually into circularity at said smaller end.
4. An eyelet of ductile metal the barrel of which is provided with a flange at one end, a tapering portion at the other end, and a circular series of work-engaging corrugations that converge and merge gradually into said tapering portion, the smaller end of said tapering portion being circular.
5. An eyelet of ductile metal the barrel of which

is circular at both ends and provided with a flange at one end and with one or more longitudinally extending corrugations between its ends.

6. An eyelet of ductile metal the barrel of which is circular at both ends, tapered at one end, and provided with a flange at the other end and with one or more longitudinally extending corrugations between its ends.

7. An eyelet of ductile metal the barrel of which has circular ends of different diameters, a flange at the larger end, and one or more corrugations extending lengthwise between its ends.

8. An eyelet of ductile metal the barrel of which has circular ends of different diameters and one or more corrugations extending lengthwise between its ends, the larger end being provided with a flange and the smaller end being tapered.

9. An eyelet of ductile metal the barrel of which has circular ends, a flange at one end, and one or more indented portions between its ends forming longitudinally extending corrugations.

10. An eyelet of ductile metal having a barrel, a flange at one end thereof, the other end being tapered and circular, and a circular series of indented portions forming longitudinally extending corrugations that merge gradually into the intervening external corrugations adjacent to said other end.

11. An eyelet of ductile metal having a barrel, a flange at one end thereof, the other end of the barrel being circular and smaller than the flanged end, and one or more longitudinally extending corrugations that merge into circularity near said smaller end.

12. An eyelet of ductile metal the barrel of which tapers from end to end and has a greater degree of taper at its smaller end than elsewhere, said smaller end being circular, the larger end having a flange, and the barrel having one or more corrugations extending lengthwise thereof.

13. An eyelet of ductile metal the barrel of which has circular ends of different diameters, a circular series of indented corrugations extending lengthwise thereof nearly but not quite to each end, work-engaging corrugations alternating with said indented corrugations and converging toward the smaller end, and a flange at the larger end.

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