

May 16, 1950

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2,507,638

METHOD OF FORMING PLASTIC FASTENINGS

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2 Sheets-Sheet 1

Fig. 1

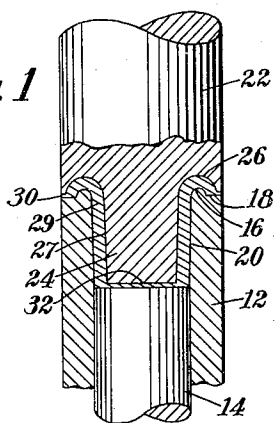


Fig. 2

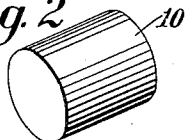


Fig. 5

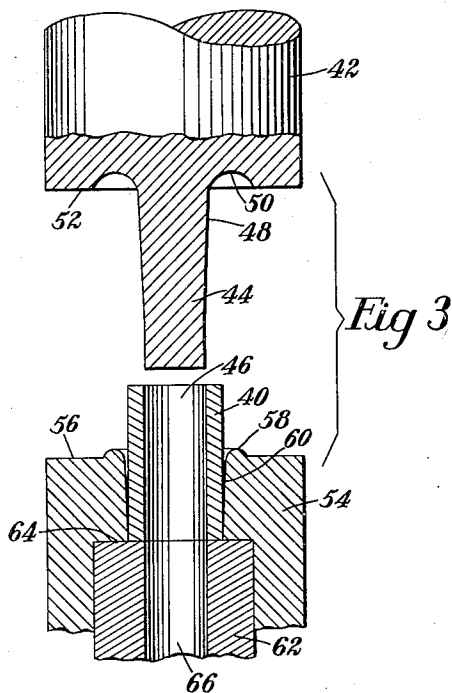
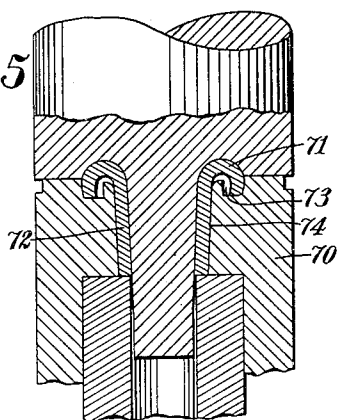


Fig. 3

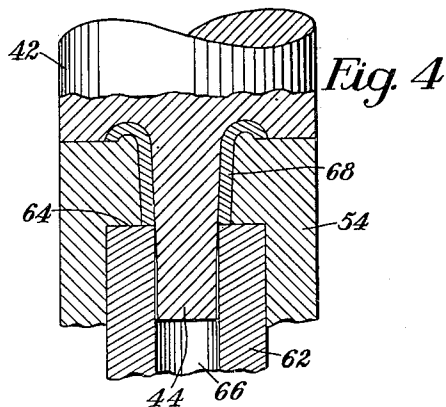


Fig. 4

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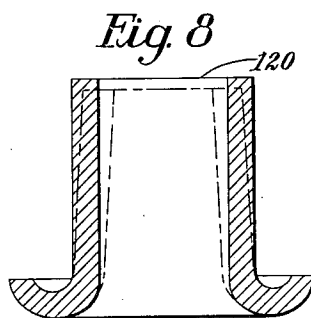
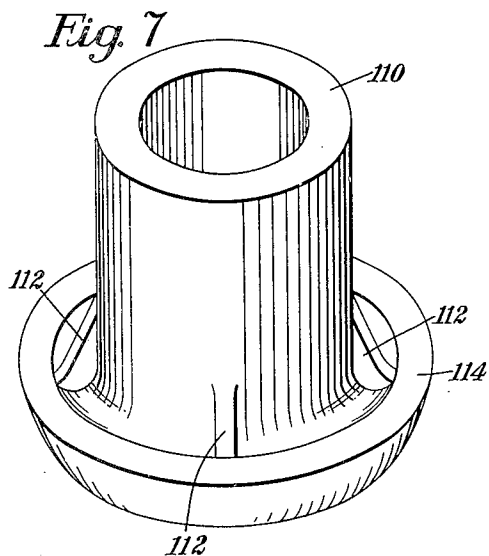
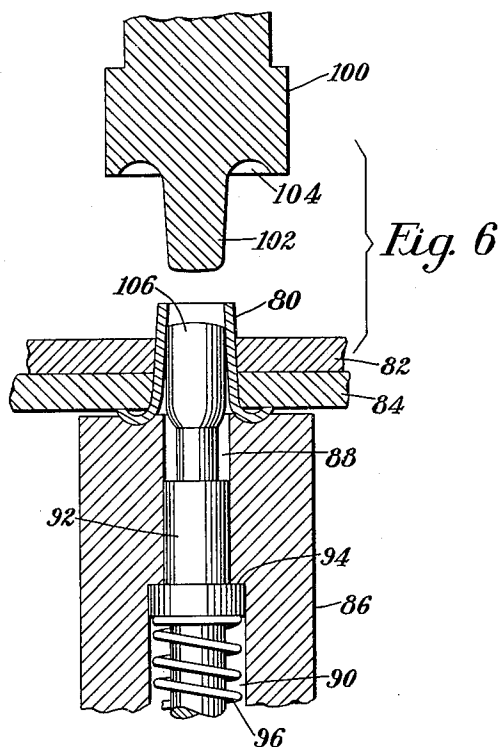
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METHOD OF FORMING PLASTIC FASTENINGS

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Application April 3, 1947, Serial No. 739,147

2 Claims. (Cl. 18—48)

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This invention relates to a method of forming plastic fastenings, such as rivets, grommets, or eyelets, each of which possesses at least one flange or enlarged portion to aid in retaining the fastening in its desired relative position on a work piece such as a shoe upper, sheet of material or on some other object. The invention also relates to the articles produced by carrying out the novel method. The present application is a continuation-in-part of application Serial No. 569,035, filed December 20, 1944, now abandoned.

The art of forming plastic as well as metallic fastenings has taught that if they are to be retained in position on the materials to which they are affixed they should possess considerable resistance to distortion as well as to shock and that the flanges of such fasteners should grip the material with a resilient force, necessitating great strength of the fastener. It has also been found advantageous to provide antitwist means whereby the fastener is prevented from rotating when set and thus becoming loose. Rotation of fasteners obviously would weaken their grip upon the material to which they are affixed and such fasteners are likely to pull out particularly if used upon relatively soft material such as leather or cloth.

Metallic fastenings have proved satisfactory in the past but their use is attended with several difficulties heretofore found unavoidable. Metallic eyelets, for example, must possess a finish which will be smooth to the touch, permit laces to be drawn through them with a minimum of friction and possess a neat appearance and for these reasons, the eyelet forming step (making the unset eyelet) is usually followed by application of a finish of some sort. Such eyelets must be upset after their insertion in material to which they are to be attached and care must be taken not to injure the finish on that portion of the eyelet to be exposed to view during use, with the result that the end of the eyelet which is finally upset to clinch a work piece is necessarily left rough and because of the roughness is concealed as much as possible. Shoe eyelets, as a specific example, must be as smooth as possible in order to prevent undue wear on the lacings. In forming unset metallic fastenings it is impractical to form antitwist projections or serrations beneath their flanges (despite the advantages to be derived in using such projections or serrations) as the costs in making and using the necessary dies would be prohibitive. Fastenings of this type are made by the thousands and difficulties which otherwise would appear negligible become insurmountable in practicable manufacturing procedure.

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Plastic fastenings have been made in the past by molding in which process a measured quantity of plastic is placed in the cavity of a heated open mold and the mold is closed under pressure to consolidate the compound and form the material to the shape of the mold. Thermosetting compounds are then hardened by further heat under pressure and thermoplastic compounds are hardened by chilling the mold. It is well known that plastics possess inherent characteristics of great value, among them being listed substantial tensile strength, resistance against corrosion and other chemical action, dimensional stability, attractive appearance, durability, light weight, electrical resistance, high dielectric strength, and low thermal conductivity. Despite these known advantages the use of plastic fasteners has not seriously challenged the extensive use of metallic fasteners because of the difficulties of charging the dies, properly heating and/or cooling during formation and/or setting of the plastic fasteners as well as the lack of holding power of such fasteners. As the commercial production of fasteners must be rapid, sufficient time cannot be allowed for adequate polymerization of thermosetting plastics, and conventional cooling technique for setting other types of resinous plastics is also too slow.

It is to be understood that the term "cold working" as used hereinafter, is intended to refer to the working of the fastener material at substantially room temperatures. In other words, the requisite operations are carried on at a temperature which is not raised to a point where the plasticity of the material is unduly increased. The term "forming" as used hereinafter is intended to refer to the making or swaging of an unset fastener from an initial rigid blank of material as well as to the upsetting or swaging of an unset fastening in affixing it to a work piece. In other words, the fastening is undergoing formation whether the operation of "forming" be an earlier or a final step in producing the ultimate article.

It is an object of the present invention to provide a method of forming fasteners, such as rivets, grommets or eyelets which includes the application of mechanical stress upon thermoplastic resinous material between dies to cause the material to flow and simultaneously improve the physical characteristics of the material and therefore result in the production of improved fasteners. Another object is to provide an improved method for forming or upsetting a fastener in fixed position upon a work piece by subject-

ing a thermoplastic resinous fastener inserted in the work piece to mechanical stress and thereby altering the nature of the material because of said stress and improve the quality of the fastener. A further object is to provide a method of forming an improved fastener preferably by means of a single impact or blow upon a rigid plastic blank or tabletted plastic preform, such blank being in the shape of a solid rod, a tubular rod or an unset fastener. Another object is to form an improved thermoplastic blank or thermoplastic fastener by application of mechanical stress imparted through striking action and straight-line relative motion of a plunger and without the application of heat otherwise derived. A further object is to provide an improved method of forming thermoplastic fastener having anti-twist projections and also surfaces to be exposed during use of the fastener, which surfaces are smooth. It is also an object to provide a method of forming an improved and one-piece fastener of a material which permits adoption of a variety of shapes and also gives a wide choice of colors without utilizing a supplementary finishing operation.

These and other important aspects of the invention and novel combinations of parts will now be described in detail in the specification and then pointed out more particularly in the appended claims.

In the drawings,

Fig. 1 is a view, partially in section, of three dies or die members and an unset eyelet compressed by those members;

Fig. 2 is a perspective view of a solid thermoplastic blank in rod form;

Fig. 3 is a sectional view of dies used in forming an unset eyelet and also showing a thermoplastic tubular blank in position to be operated upon by those dies;

Fig. 4 is a view, partially in section, of the parts shown in Fig. 3 but with the dies closed and the unset eyelet formed;

Fig. 5 is a view similar to Fig. 4 but showing a modified form of lower die;

Fig. 6 is a cross sectional view of an unset eyelet thrust through perforated sheets of material with dies in position ready to set the eyelet;

Fig. 7 is a view in perspective of an unset eyelet with antitwist projections thereon; and

Fig. 8 is a cross sectional view, in full lines, of a finished unset eyelet with dotted lines representing the form of the eyelet at an earlier stage.

Figs. 1 and 2 illustrate parts which may be used in carrying out the method. A rigid tabletted preform 10, such as shown in Fig. 2, of unplasticized polymeric thermoplastic material (it may be cut from a solid rod) is placed within a sleeve 12 (Fig. 1) and supported on the end of a rod 14 which extends up and within the sleeve 12. The upper end of the sleeve 12 is provided with an annular ridge 16 and an annular outer shoulder 18. It will be noted that the upper interior of the sleeve 12 is slightly tapered upwardly and outwardly at 20. The sleeve 12, rod 14 and an upper member 22 constitute dies which, when brought together to compress the material of the blank 10, are adapted to form an eyelet. The upper die 22 is provided with a depending male member 24 which is of such length as to almost reach the top of the rod 14 when the outer lip or edge of the die 22 comes into contact or almost into contact with the shoulder 18. The base of the male member 24 is located within or concentric with an annular channel 26

of the proper shape to form the bell of a desired eyelet. It will be noted that a clearance or space is left between the tapered surface 20 of the lower die 12 and the outer surface 27 (which is also tapered) of the male member 24. When the rigid tabletted preform 10 has been placed within the sleeve 12, as stated above, the three dies 12, 14 and 22 are brought together quickly (a single blow or impact is preferable but not essential) and into their positions as shown in Fig. 1. The exterior surface and lower end of the blank are buttressed by the lower dies during the endwise compression operation. The volume of the space left between the three dies when in their closed positions is made equivalent, or substantially equivalent, to the volume of the preform 10. If there should be any portion of plastic material in the preform which is in excess of that necessary to form the eyelet, such excess may be squeezed out or displaced outwardly from the upper end of the plastic mass and through the small opening 30 which is caused to remain between the dies 12 and 22 after those dies are brought together.

It is preferred that the rod 14 and sleeve 12 be connected together rigidly during the formation of the unset eyelet and in their relative positions as shown in Fig. 1. With such a condition and with tools as shown in Fig. 1 a small amount of plastic material in the form of a thin membrane 32 is unavoidably left between the top of rod 14 and the base of the member 24 and any excess of plastic material, however small or large, may pass outwardly through the passage 30 at the edge of the eyelet flange or bell. It is obvious, however, that the rod 14 may be permitted to yield when an excessive pressure is applied and be moved downwardly a slight amount in relation to the sleeve 12. Such a yielding motion of the rod 14 with relation to the sleeve 12 may easily be secured by the use of a strong compression spring, somewhat like the construction shown in Fig. 6, but with such an apparatus the present invention is not concerned. If the die or plunger 22 is caused to contact the die 12, any excess of plastic at the opening 30 will be pinched off, which operation would be advantageous in some instances.

A single, momentary or sharp impact or striking action of the dies is permissible as stated above and is preferred for commercial production of the fastenings but it is clear that the invention may be practiced through either one or more straight-line relative motions of a plunger such as the upper die 22. With the tools or dies as shown in Fig. 1 the unset fastener 29 remains on the male member 24 of the upper die or plunger 22 after the tools are separated. The eyelet 29 may easily be removed from the male member 24, although if deemed necessary in the interest of rapid production, supplementary means, not shown, may be utilized to remove the product from the tool 22. The tools may be so designed and proportioned that the unset eyelet will remain in the sleeve 12 after the tool 22 is removed. This being the case, the tools 12 and 14 may be moved relatively to one another in such a way as to expel the eyelet from the top of the tool or die 12.

When the male member 24 displaces the material of the solid preform 10 outwardly and upwardly, the material itself undergoes some form of structural change, for it has been found that the material of the unset fastener 29, formed in the manner illustrated, is stronger and much less

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brittle than the material of the blank 10 prior to the cold working operation.

For some unknown reason, the thin membrane 32 of plastic material easily separates from the main body of the eyelet 29 by a subsequent and lightly executed punching operation.

In Fig. 3 a different manner of carrying out the invention is depicted and a different form of tools is used. Instead of using a solid preform 10, as shown in Fig. 2, a tubular, rigid preform 40 of similar or analogous material is used. An upper die or plunger 42 is provided having an elongated male member 44, the lower end of which (for a short distance) is of such diameter as to just enter the passage 46 within the tubular preform 40. The upper portion 48 of the male member 44 tapers outwardly and upwardly and flares outwardly at its top to form the wall of an annular groove or trough 50. A shoulder 52 is provided on the die 42 and constitutes a stop surface when the dies are brought together. The lower dies of Fig. 3 consist in an outer sleeve 54 having an annular shoulder 56 and an annular ridge 58. An upwardly and outwardly flaring passage 60 is formed in the die 54 and the bottom diameter of the passage 60 is such as to snugly receive the preform 40. An inner die 62 is rigidly affixed to the die or sleeve 54 and bears against a shoulder 64 formed on the interior of the die 54. The inner die 62 is provided with a passage 66 of such cross section as with a very slight clearance to receive the lower end of the male member 44, as will subsequently appear.

In operating the dies of Fig. 3 they are brought together into positions shown in Fig. 4 and an unset eyelet 68 is formed. It will be noted that in this case the male member plunger, or upper die 42 cold works the eyelet material outwardly and that the dies are such and are operated in such a way as to eliminate any flashing 32 or possible rim on the bell 26 such as shown in Fig. 1. In Fig. 4 no provision is depicted for permitting an excess of plastic material to escape, and in using such tools or dies in the manner described, the volumes of the tubular preform and the space left between the tools when they are brought together must be accurately calculated and be equal.

In Fig. 5 an unset eyelet is shown which has been formed in the same manner as depicted in Figs. 3 and 4, but a different type of lower die has been used. In place of the die 54, a die 70 is utilized, and this die is so formed as to permit excess plastic material to escape to the underside of the eyelet bell 71 as the eyelet 72 is formed. Such operation is permitted by forming an annular chamber 73 in the top surface of the die 70, which chamber is concentric with the tapered and conical wall 74 of the die 70. With such dies (and many modifications thereof may be used) the flange or bell of the eyelet has been made to double up and/or assume various shapes without changing the over-all length of the eyelet or the thickness of the bell. With such an expedient the volumes of the preform and the space between the closed dies need not be so accurately determined and doubled or reversed bells or flanges have advantages for specific uses.

A slightly tapered unset eyelet 80 is shown in Fig. 6 as thrust through the perforations of two layers 82 and 84 of material. These layers may represent an enlarged view of the upper and lining of a shoe. The unset eyelet 80 is maintained in position, as shown, by the layers 82 and 84 as well as by a lower die 86. Coaxial cyl-

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inders 88 and 90 are provided within the die 86 and a piston 92 is mounted therein and biased to its uppermost position (determined by a shoulder arrangement 94) by the compression of a spring 96. The dies are placed in position so that eyelet 80 is in a position coaxial with an upper die or plunger 100. The upper die 100 has a projection or male member 102 and an annular channel 104 whereby it may serve as a setting or upsetting tool. Piston 92 has an end portion 106 and this portion, together with projection 102, is slightly rounded to make a smooth engagement with the eyelet 80, and the setting tool or die 100 is forced downwardly in a straight-line motion to such a position that the eyelet is pressed or set and the second flange is formed. The peripheries or edges of both flanges of the eyelet 80 will sink slightly into the material layers 82 and 84 to which the eyelet is affixed during the ultimate formative step of setting or upsetting the eyelet.

The perspective view of Fig. 7 shows an eyelet 110 which is similar to the one produced by the tools or dies of Figs. 3 and 4 except that antitwist projections 112 are formed under a flange 114, as shown. Such projections may be easily provided by making suitable cuts (not shown) in the annular ridge 58 of the die 54, as such ridge is shown in Fig. 3. These projections 112 may take any of an infinite variety of form and may be placed anywhere on the work engaging surface or surfaces of the fastener and are provided as an added precaution against the fastener rotating and thereby becoming loose in the material to which it is affixed. It will be appreciated that a method carried out in accordance with the present invention permits the formation of projections such as projections 112 and at the same time does not detract from the smoothness of fastener surfaces which are not in contact with the work to which the fastener is affixed, i. e. exposed fastener surfaces are smooth.

The unset eyelet 120 of Fig. 8 graphically illustrates how the thermoplastic material of the main longitudinal portion of a fastener may be cold worked laterally, that is, perpendicular to its axis, not only to change the taper but also to decrease the wall thickness and increase the length. Such an unset eyelet may be made initially by a molding procedure or by cold working (the latter operation being in accordance with the principles of the present invention) into the form as shown by the dotted lines. It may be made by the molding procedure, as stated, and this procedure may be called compression molding (that is, by the use of heat in which the characteristics of the plastic material are not appreciably changed during the formation of the unset fastener) and then the fastener may be completed into a set fastener (2 flanges or bells) or into an unset fastener (one flange or bell) in accordance with the method of the present invention. In other words, a molded fastener or blank may be made without securing the advantages of the present invention and such articles may then be cold worked to form the first or second flange and this final step will enable the operator to secure improved characteristics for the fastener material. The full lines in Fig. 8 are to show the proportions to which it has been found advantageous in a specific instance to cold work unset eyelets of the shape shown in dotted lines.

Advantages of this invention cannot be secured by compression molding, in which process (as stated above) a measured quantity of plastic is

placed in the cavity of a heated open mold and the mold is closed under pressure to consolidate the compound and form it to the shape of the mold. If thermosetting compounds are used in such a process they must then be hardened by further heat under pressure. If thermoplastic compounds are thus used the mold must be chilled. In the application of the present invention no heating (except the heat of impact which is so slight that it is extremely difficult and more often impossible to detect) is necessary and the need for chilling is eliminated. Not only are the necessary steps less in number when the method of this invention is practiced and compared with compression molding but the completed fasteners withstand heat distortion much better than do hot set eyelets, for example, and also possess a greater resistance to shock. It is interesting to note that if the plastic material is a copolymer of vinyl chloride and vinyl acetate, it can be formed cold initially and then set cold, as is done by applicant to produce a fastener of great strength. However, if that same material is formed cold initially and then set at customary compression-molding temperature, the resulting article may have a fine appearance but will prove weak in use and may shatter. This same copolymer, if made hot into an eyelet, can be set cold to produce a strong article.

Blanks of solid or tubular rod material may be used, as stated heretofore, and the plastic composition may be the copolymer already referred to or some other polymeric material which is rigid, thermoplastic, resinous, and substantially unplasticized. Among the materials which are suitable may be mentioned polyamide, polyvinyl chloride, vinyl chloride copolymers, vinylidene chloride copolymers, polymethyl methacrylate, cellulose acetate, cellulose acetate butyrate, and ethyl cellulose. The particular type of plastic material to be used should obviously be selected in accordance with the particular use to which the fastening is to be put. In general, no plasticizer should be used or, if it is used, the quantity should be small. The suitable plastic materials, as customarily sold on the market, contain a small amount of lubricant which is essential in order that the materials may be processed during production into rods by extrusion. This small amount of lubricant is not deleterious in the carrying out of the present invention. It is obvious also that fillers and coloring materials may be in the plastic compositions used in carrying out the present invention.

The motion of the dies or tools relative to each other or the blank worked upon may be varied in extent, rapidity and in other particulars. It is essential, however, that at least one of the dies or plungers be moved bodily and in a straight line relative to the blank. One of the dies may be rotated as well as moved in a straight-line relation to the blank and such an expedient would employ the principles of the present invention for it is the compression, striking or swaging of the blank through the

straight-line relative motion of a plunger and without application of extraneous heating that secures the novel and valuable results.

The elimination of the need for extraneous heating and/or cooling and the ease of charging rigid blanks into proper position between the dies contribute to the rapidity of fastener manufacture. Additional steps for applying and protecting a finish are not necessary as the fastenings inherently possess any finish of desired smoothness or color. The increased strength given to the fastenings of this invention, and particularly to their flanges, by virtue of the cold working, contribute greatly to their holding power or resilient grip on work pieces to which they are affixed, and the provision of antitwist projections is entirely feasible without effecting the rate or cost of manufacture.

It has been assumed that the unexpected alteration and improvement in the physical characteristics of the fastener material in the practice of the present invention is due to the orientation or reorientation of the resin material molecules during the cold working step. This theory has been advanced, but it is clear that the value and validity of the present invention in no wise depends upon the correctness of such theory. Practice of the invention as disclosed herein will result in the formation of an improved fastener regardless of any theoretical explanation or reason for the surprising result.

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

1. The method of forming a fastener such as a rivet, grommet, or eyelet, said method including the buttressing of an exterior surface and one end of a rigid blank of thermoplastic polymeric material free of plasticizer, and striking the blank endwise while said blank is at room temperature to displace a portion of said material outwardly and thereby produce a flange.
2. The method of providing a perforated work piece with a fastener such as a rivet, grommet, or eyelet, which includes the thrusting of one end of a rigid blank of thermoplastic polymeric material free of plasticizer through and beyond a perforation in the work piece and, while said blank is at room temperature, upsetting at least one end of the fastener by striking the blank through straight-line relative motion of a plunger and the blank.

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