Sept. 17, 1963 R. H. CARLSON 3,104,161

METAL BLANK WITH EXTRUDED PORTION OF NON-CIRCULAR CROSS SECTION

Filed July 5, 1960 3 Sheets-Sheet 1

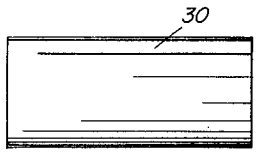


Fig. 1

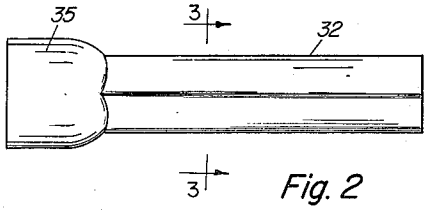


Fig. 2

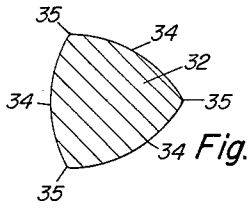


Fig. 3

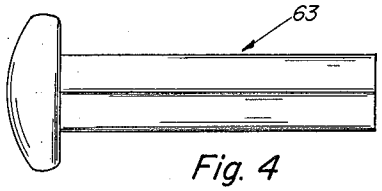


Fig. 4

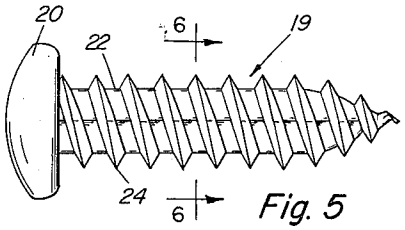


Fig. 5

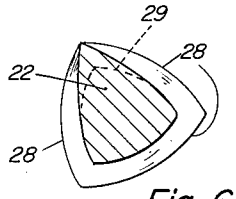


Fig. 6

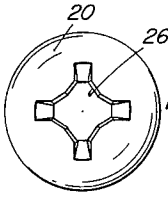


Fig. 7

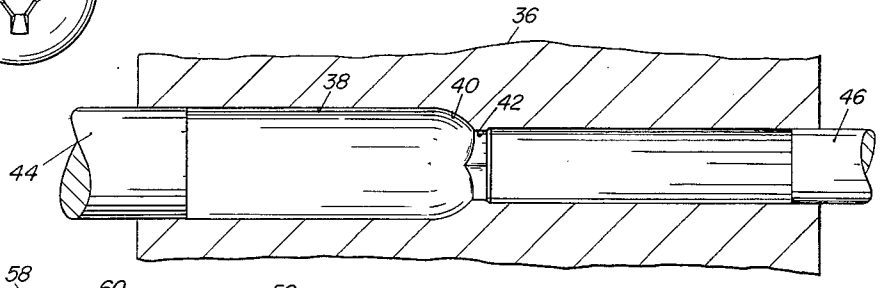


Fig. 8

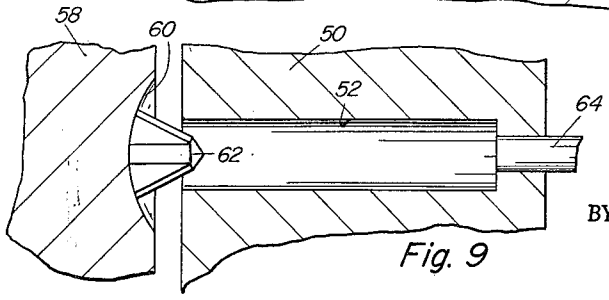


Fig. 9

INVENTOR.
Raymond H. Carlson
BY
Buckhorn, Cheatham & Blore
ATTORNEYS

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METAL BLANK WITH EXTRUDED PORTION OF NON-CIRCULAR CROSS SECTION

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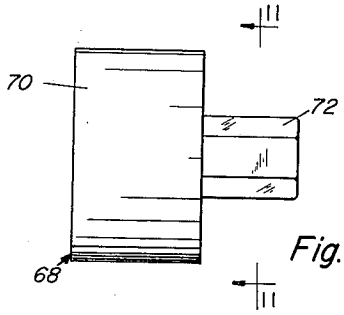


Fig. 10

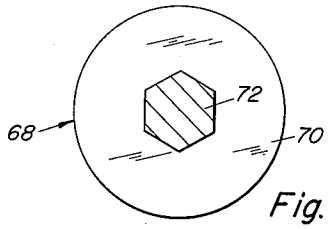


Fig. 11

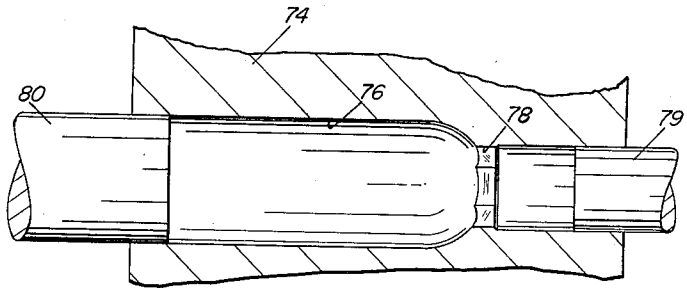


Fig. 12

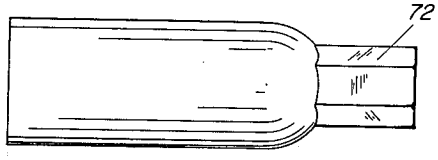


Fig. 13

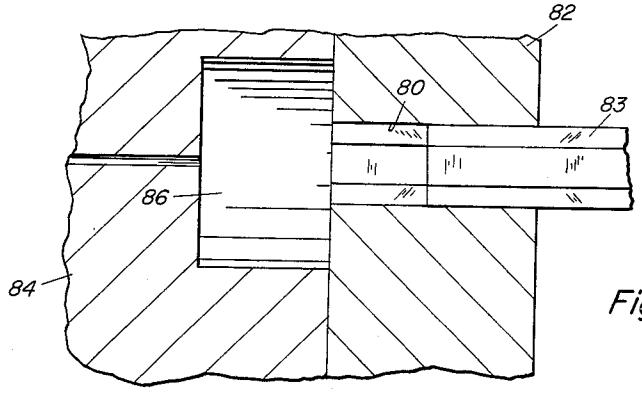


Fig. 14

INVENTOR.
Raymond H. Carlson

BY
Buckhorn, Cheatham & Blore

ATTORNEYS

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METAL BLANK WITH EXTRUDED PORTION OF NON-CIRCULAR CROSS SECTION

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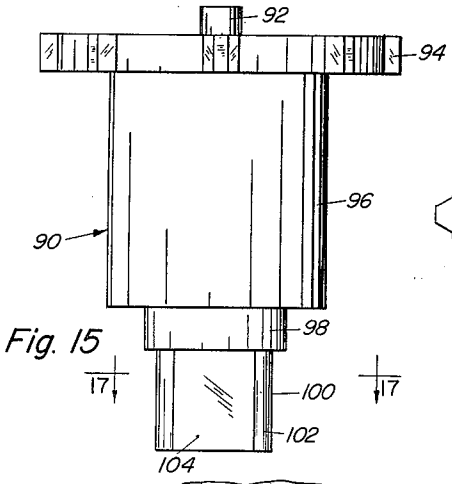


Fig. 15

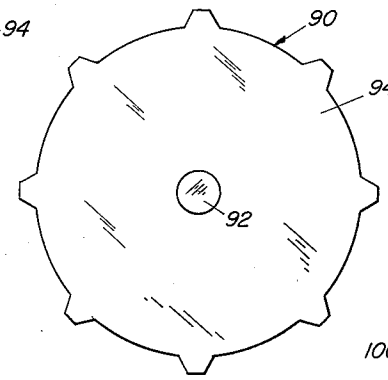


Fig. 16

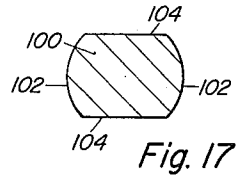


Fig. 17

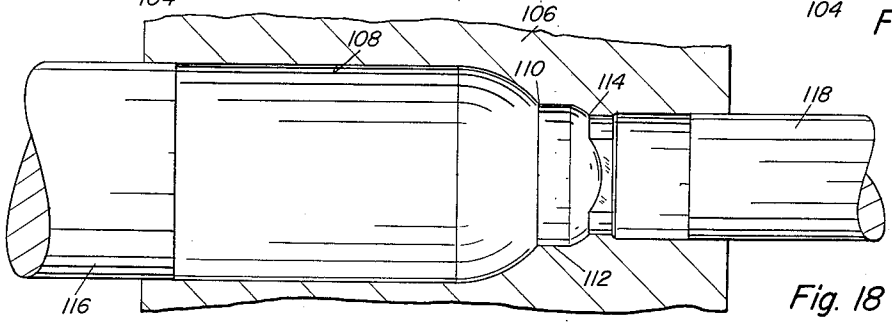


Fig. 18

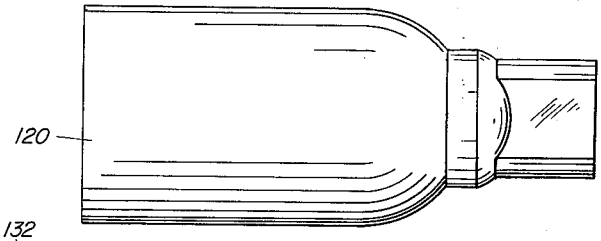


Fig. 19

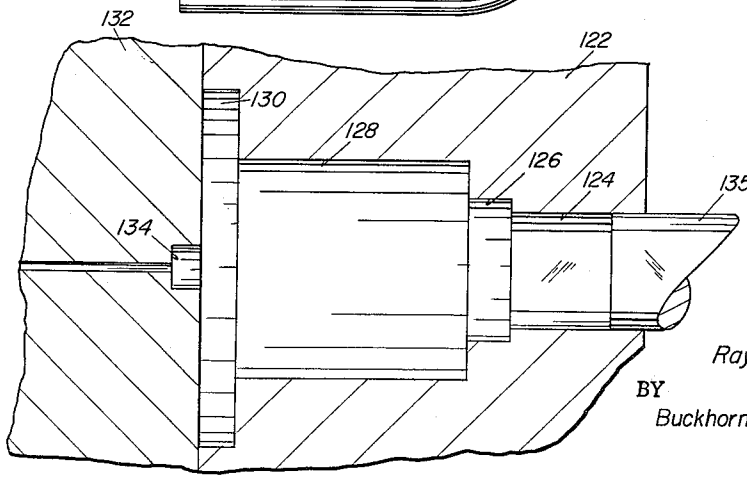


Fig. 20

INVENTOR.
Raymond H. Carlson
BY
Buckhorn, Cheatham & Blore
ATTORNEYS

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3,104,161

METAL BLANK WITH EXTRUDED PORTION OF NON-CIRCULAR CROSS SECTION

Raymond H. Carlson, Rockford, Ill., assignor to Textron Industries, Inc., Rockford, Ill., a corporation of Delaware

Filed July 5, 1960, Ser. No. 40,738
1 Claim. (Cl. 29—190)

The present invention relates to metal articles and to methods of manufacturing the same.

The invention is particularly concerned with metal articles having a head portion of circular cross section and a shank portion of non-circular cross section which has a cross-sectional area less than about 60% that of the head and in which the largest transverse dimension of the shank is no greater than the head diameter. Heretofore, in manufacturing such articles, it was generally necessary to form them by machining or performing some other metal cutting process upon a metal blank. Accordingly, the cost of the articles has been excessively high. Attempts have been made to upset the head portion from a workpiece of the shape of the shank, but such attempts have been markedly unsuccessful since it has not been possible to upset a head of circular cross section from an irregularly shaped workpiece. Folds and undesirable irregular grain structures are formed in such upset heads and it is not possible to work them further as, for example, to form a head having a driving tool recess.

It is, therefore, an object of the invention to provide a new and improved process for making metal articles having a cylindrical head portion and a non-circular shank portion of lesser cross-sectional area.

A further object of the invention is to provide a more economical process for manufacturing articles of the class described.

Another object is to provide a new article of manufacture comprising an article having a head and a smaller, extruded, non-circular shank.

Still another object is to provide articles of the class described having improved physical characteristics.

A specific object of the invention is to provide a new and improved process for forming blanks for self-tapping screws.

Other objects and advantages of the invention will become more apparent hereinafter.

In accordance with the illustrated embodiment of the present invention, articles having a cylindrical head portion and an integral shank portion of non-circular cross section are formed by extruding a cylindrical workpiece of a diameter of the head portion through an extrusion orifice having a configuration complementary to that desired in the shank portion, the extrusion being ceased when the volume of the unextruded portion of the workpiece is substantially equal to that desired in the head portion of the completed article.

For a more detailed description of the invention, reference is made to the accompanying drawings wherein:

FIG. 1 is an elevation of a workpiece from which a screw may be made in accordance with the invention;

FIG. 2 is an elevation of the workpiece after extrusion thereof in accordance with the invention;

FIG. 3 is an enlarged sectional view taken along line 3—3 of FIG. 2 showing the cross-sectional shape of the shank;

FIG. 4 is a view of the workpiece after still another forming step showing a screw blank made in accordance with the invention;

FIG. 5 is a side elevation of the completed screw;

FIG. 6 is an enlarged section taken along line 6—6 of FIG. 5 showing the shape of the shank of the screw;

FIG. 7 is a plan view of the head of the screw showing the tool receiving recess therein;

FIG. 8 is a sectional view of the extrusion die utilized in forming the workpiece shown in FIG. 2;

FIG. 9 is a sectional view of the dies utilized to finish form the head of the screw blank and punch the recess therein;

FIG. 10 is an elevation of another article made in accordance with the invention;

FIG. 11 is a sectional view taken along line 11—11 of FIG. 10;

FIG. 12 is a sectional view of an extrusion die utilized in the process of forming the article shown in FIGS. 10 and 11;

FIG. 13 is a view of the workpiece after extrusion through the die of FIG. 12;

FIG. 14 is a sectional view of a heading die used in the next forming step;

FIG. 15 is an elevation of still another article made in accordance with the invention;

FIG. 16 is a plan view of the article;

FIG. 17 is a sectional view taken along line 17—17 of FIG. 15;

FIG. 18 is a sectional view of the extrusion die used in forming the article of FIG. 16;

FIG. 19 is a view of the workpiece after extrusion thereof; and

FIG. 20 is a sectional view of a heading die used in making the article of FIG. 16.

Illustrated in FIGS. 1 to 9 is a screw and a process for making the same in accordance with the invention. The completed screw **19** as shown in FIGS. 5, 6 and 7 comprises a pan-type head **20** and an integral shank **22** formed with threads **24**. The head **20** is preferably provided with a cruciform tool receiving recess **26** which may be of the type shown in Tomalis Patent No. 2,474,994.

The screw **19** is of a self-tapping type and the shank thereof is generally triangular in cross-sectional configuration being formed with three arcuate sides **28** as indicated in FIG. 6. The form of the thread roots is indicated by the dotted line **29**. A more detailed description of such a screw may be found in application, Serial No. 819,167, filed June 9, 1959, now abandoned.

The screw **19** is manufactured in accordance with the present invention by first providing a cylindrical workpiece **30** having a diameter slightly less than that of the head **20** but greater than that of the screw shank **22**. Preferably the cross-sectional area of the workpiece is about ⅔ greater than that of the shank so that a reduction of at least about 40 percent will be necessary to form the shank from the workpiece. The workpiece **30** may be severed from wire stock or formed in any other desired manner. The workpiece **30** is first subjected to an extrusion operation wherein it is forced through an extrusion die to extrude a shank portion **32** having a generally triangular cross-section, such as shown in FIG. 3, having transverse dimensions intermediate the root and crest dimensions of the threads **24**. Referring to FIG. 3, the shank **32** is formed with three sides **34**, each of which is arcuate about a point **35** located substantially at the intersection of the other two sides of the shank. As shown, the corners formed by the intersections of the sides **34** are preferably provided with a small radius.

Preferably the extrusion of the workpiece **30** is performed in a die **36**, such as shown in FIG. 8, having a cylindrical opening **38** capable of receiving the entire workpiece **30** and which opening is formed with a concavely curved bottom surface **40** leading to an extrusion orifice **42** which is complementary in shape to the shank **32**. For a more detailed description of such concavely

curved dies, see my prior application, Serial No. 788,833, filed January 26, 1959, now Patent 3,072,933. As more particularly described in such patent and as shown in FIG. 8 hereof, the curve of the surface **40** conforms substantially to a generatrix revolved about the axis of said head portion, one end of which generatrix is tangential to the cylindrical side wall of the cavity **38** and curving from such side wall inwardly toward the cavity axis in a circular arc. The extruded workpiece will of course be complementary in shape to the die cavity. Endwise extrusion pressure may be applied to a workpiece **30** positioned within the die **36** by a ram or plunger **44** and which pressure is applied to the workpiece until the volume of the unextruded portion **35** of the workpiece is substantially equal to the head portion **20** of the finished screw. Thereafter, the ram **44** is removed and the workpiece extracted from the extrusion die as by a knock-out pin **46**. The workpiece is then positioned in a heading die **50** as shown in FIG. 9 having a complementary aperture **52** for receiving the shank **32** of the workpiece. The head or unextruded portion **35** of the workpiece is then struck a blow with a recess forming die **58** which is formed with a concave recess **60** having the shape of the screw head **20** and a nib **62** complementary in shape to the recess **26** so as to finish form the head **20** and form a blank as shown at **63** in FIG. 4. The screw blank thus formed is then extracted from the die **50** by means of a knock-out punch **64** or other suitable means whereafter the threads **24** may be formed on the shank as by a rolling process or other suitable manner anud the threads can be hardened by any conventional process. It is to be expressly understood that no claim is made in the present application to the screw **19** per se, but only to the blank **63** and the process herein described for forming the same.

An advantage of the process of the invention is that the tensile and yield strength of the material in the shank **32** is materially increased by the working of the metal caused by the sizeable reduction in area in the extrusion of the shank. With a reduction of the order of 40 percent, increase in tensile strength of between 35 to 40 percent is obtained. This is particularly desirable inasmuch as high tensile strength is desired in self-tapping screws. Because of this increase less expensive alloys may be utilized to form the blanks than would be required if such increase in strength did not occur. At the same time the head portion of the workpiece remaining after the extrusion process can be easily worked to shape the same and form a strong, flawless driving head. Thus the process of the invention enables the manufacture of screws of superior quality relatively easily and inexpensively. As mentioned previously upsetting processes are not feasible in forming screws of this nature and machining costs are so excessive as to make it utterly impractical to manufacture the screws by any process involving machining. Obviously, while the invention has been illustrated in connection with a pan head type screw having a Phillips recess, screws of other head shapes and tool receiving recesses may be provided on work blanks in accordance with the invention.

To illustrate another application of the process of the invention and another type of article which may be made in accordance therewith, there is illustrated in FIGS. 10 and 11 a punch **68** for use in punching recesses in an Allen type fastener. Such a punch comprises a cylindrical head portion **70** and a hexagonal shank **72**. The punch **68** is formed by providing a cylindrical workpiece having the volume of the finished punch and a diameter such that the cross-sectional area of the shank **72** is no more than about 60 percent of the cross sectional area of workpiece. Such a workpiece is positioned in a round bottom extrusion die such as shown at **74** in FIG. 12 having a workpiece receiving opening **76** of the diameter of the workpiece and an extrusion orifice **78** complementary to the shank **72**. Endwise pressure is applied to the cylindrical workpiece by a ram **80** to extrude from the workpiece the shank **72**. A knockout punch **79** is provided for assisting in removal of the part after extrusion of the shank **72**. The workpiece at this point appears as shown in FIG. 13. Thereafter, the shank **72** is placed in the hexagonal cavity **80** of a flat surfaced holding die **82** having a cooperating back up punch **83** and the end of the workpiece struck with a heading punch **84** having a cavity **86** substantially complementary to the head **70** to upset the head portion and square up the rounded surfaces formed by the extrusion of the shank **72**. The ends of the punch shank **72** can then be rounded and the punch treated to surface harden the same as desired. Here again the strengthening of the shank **72** by the extrusion steps is greatly advantageous in producing a punch that will have prolonged life.

Obviously, it would be expensive to form an article such as shown in FIG. 10 by machining and upsetting of hexagonal bar stock cannot be feasibly performed.

Still another example of an article which may be made in accordance with the present invention is shown in FIGS. 15, 16 and 17 and which article comprises a part **90** for a door lock and includes from one end to the other a stub shaft **92**, a cylindrical ratchet portion **94**, a body **96**, a smaller cylindrical section or neck **98**, and a shank **100** formed with opposite semi-circular walls **102** and opposite flat side walls **104**. Such an article is formed by providing a cylindrical workpiece having essentially the diameter of the body **96** and a volume of the finished article. This is positioned in an extrusion die such shown at **106** in FIG. 18 having an opening **108** of a diameter and length capable of receiving the initial cylindrical workpiece. The bottom of the opening **108** is concavely curved and leads to an extrusion orifice **110** having substantially the diameter of the section **98**. The extrusion orifice **110** is at the head end of a passage **112**, the bottom of the passage being concavely curved and leading to an extrusion orifice **114** complementary in cross section to the shank **94**. Endwise extrusion pressure is applied to the cylindrical workpiece positioned in the opening **108** by means of a ram **116** and the workpiece is caused to extrude through the orifices **110**, **114** until the desired amount of extrusion is completed whereafter pressure is ceased and the ram backed out and the workpiece extracted by suitable means such as a knock-out punch **118**. The workpiece at this point will appear as shown at **120** in FIG. 19.

The workpiece **120** is next positioned in the recess of an upsetting die **122** shown in FIG. 19 having a portion **124** complementary in cross section to the shank **100**, a cylindrical portion **126** complementary to the neck **98**, a cylindrical portion **128** complementary to the body **90** and an outer cylindrical recess **130** of the maximum diameter of the ratchet portion **94**. The end of the workpiece is then struck a blow with a punch **132** having a recess **134** complementary to the stub shaft **92** to drive the workpiece forwardly against a back up punch **135** and cause the rounded extrusion surfaces to square up and the outer end of the workpiece to upset into the recess portion **130**. The workpiece is then removed and the ratchet portion is sheared to form the teeth thereon. By the process described the door-lock part **90** can be manufactured easily and inexpensively. It will be obvious that it would be virtually if not absolutely impossible to manufacture such a part by upsetting stock having the shape of the shank **100** and the cost of machining such a part would be many times the cost by the process described.

Having illustrated and described the preferred embodiments of the present invention, it should be apparent to those skilled in the art that the invention permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claim.

I claim:

An article of manufacture comprising a metal blank

having a cylindrical, unworked head portion of a desired volume, and an integral, cold extruded shank portion of non-circular cross section,

the surface of said shank portion being smooth in the longitudinal direction,

the major transverse dimension of which shank portion is no greater than the diameter of said head portion,

the cross sectional area of said shank portion being less than about 60% of the cross sectional area of said head portion, the tensile strength of said shank portion being at least about 35 percent greater than the tensile strength of said head portion,

said blank having a smooth, convexly curved transition region between the circular part of said head portion and said shank portion, the curve of said transition region conforming substantially to a generatrix revolved about the axis of said head portion, one end

of said generatrix being tangential to the side wall of said head portion and curving therefrom in a circular arc inwardly toward said axis.

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