May 17, 1955 C. H. SCHLECHT ET AL 2,708,512

COMPOSITE DIE RING

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Fig. 1.

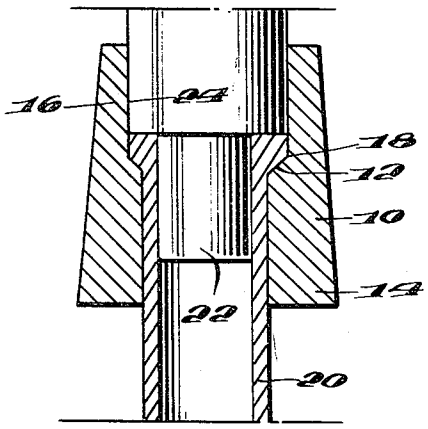


Fig. 2.

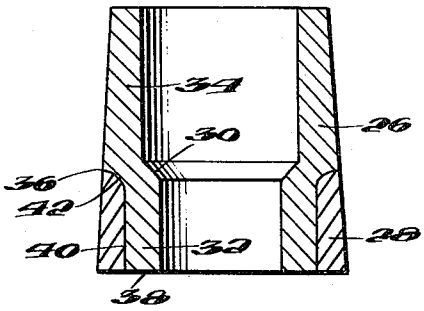


Fig. 4.

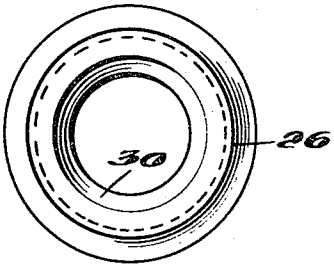


Fig. 3.

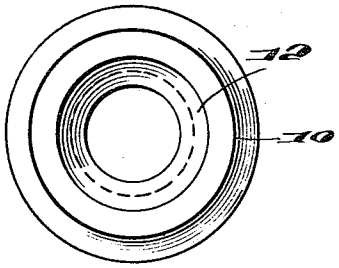


Fig. 6.

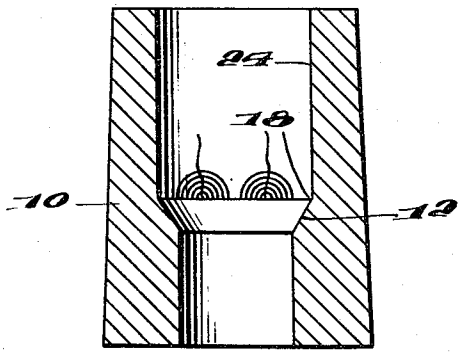
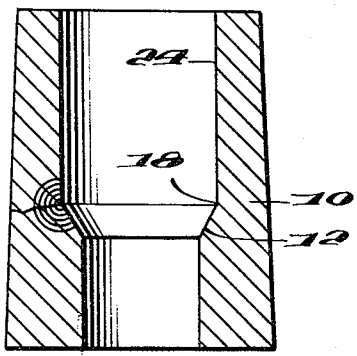


Fig. 5.



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COMPOSITE DIE RING

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2 Claims. (Cl. 207—17)

This invention relates to improvements in dies, and more specifically to improved designs of die rings used for the cold extrusion of metals. This invention is particularly useful, but not limited in application, to the manufacture of cartridge shells, shell bodies, and shell casings. It can also be readily used in the cold extrusion of cylindrical tubing made of carbon steels of either low, medium, and high carbon content as well as alloy steels containing chromium, nickel, manganese and molybdenum, and other hard metals having the same properties or characteristics as plain carbon or alloy steels. The invention is particularly suited for use in the extrusion of solid or hollow tubular shapes where fine finish, close tolerances and high physical characteristics are required.

Since the end of World War II, there has been a mounting interest by the metal fabricating industry in this country in the shaping of steel by cold extrusion processes because of the great savings in material as well as in the reduced number of machining operations required to shape the workpieces. In addition, by means of the cold extrusion processes, metal workpieces are obtained that have smooth surfaces with superior stress resistant qualities. Workpieces are also obtained which have significant increases in strength, and this makes it possible to manufacture thinner sections than heretofore feasible.

Metal tubing or shell casings have generally been shaped in the past by conventional methods, such as hot extrusion, forging, drawing, and the like. Of these methods, cold drawing of metals has some of the features of cold extrusion of metals but the former is to be differentiated from the latter in the kinds of stresses that are developed during the working operations. In cold drawing of metals, the metal is formed by the application of tensile stresses whereas in the cold extrusion of metals the workpiece is forced to flow as a result of applied compressive stresses.

Extrusion of metals can be accomplished by different types of processes, two of the most important of which are, i. e., backward extrusion and forward extrusion processes. In the first method, hot or cold metal is forced to flow in a direction opposite to the travel of the die punch or punch ram. This type of process, basically, is similar to the process of piercing of billet or bar in the first operation of the conventional pierce-and-draw method of manufacturing shell forgings. On the other hand, in forward extrusion process, the metal flows in the same direction as the die punch, and flows out of the die ahead of the punch at a speed that is greater than that of the latter.

In cold extrusion or coining of cartridge cases, shell casings, and shell bodies, solid and hollow tubing, and like products, stresses of large magnitude are developed in the conventional die ring due to the high pressure that must be applied by the die punch to the workpiece in forcing the metal to escape through the annular orifice between the die ring, which is located on the outside of the piece, and the pilot of the punch, which is located inside of the workpiece.

Conventional die rings appear to be subjected to fatigue, and tensile failure. They often fail due to a "progressive fracture." This progressive fracture is dependent upon two factors, i. e., the stress level at the die ring surface and the resistance of the metal to the propagation of any cracks that may form in the highly stressed regions of the juncture of the die ring shoulder and the die ring wall proper due to the tremendous pressures set up by the die punch in forcing the extruded metal through the annular opening between the die ring and the die pilot.

In the conventional die rings, therefore, that were subjected to such tremendous pressures, once a microscopic crack started due to the high stress concentration at the regions of the juncture of the die ring extrusion shoulder and the die ring wall proper, the crack will propagate with the working of each extruded metal piece. Once a fatigue or tensile crack started at the inner wall, it continued to progress toward the outer wall. Sooner or later the die ring either fractures completely or is discarded prior to the fracture because of this progressive stress damage.

For instance, in a conventional die ring composed of one integral piece, biaxial stresses on the surface of the die ring and triaxial stresses on the interior of the die ring, composed of tension and compression components, are set up at the regions of the notched juncture of the extrusion shoulder and the die ring proper when a metal workpiece is being extruded. These complex stresses are due to the abrupt change in configuration that takes place at the extrusion shoulder. Whenever there is an abrupt change in section, as here, stress concentrations are set up which act as centers or nuclei for cracks and which are more disastrous than the ordinary stresses that would be obtained in an unnotched member.

In addition, prior art die rings cannot be pre-loaded uniformly in a shrink ring assembly due to the varying resistance that is offered by the differences in standard die ring wall thickness. Pre-loading of die rings is a practice that has been adopted to place the die in compression so that during the extrusion process, the compression stresses must be overcome before the dies are stressed in tension. Therefore, when the factors enumerated above are acting together so as to reinforce each other, high stresses are developed in the die ring when a shell casing or tubular member or the like is being extruded. The effect of these stresses and stress concentrations is to cause failure of the die ring at the juncture of the extrusion shoulder and die ring wall, probably due to fatigue or tensile failure, by a separation of the upper part of the die ring from the lower portions, or a separation of the metal in a longitudinal direction from the extrusion shoulder.

In order to eliminate these conventional die ring failures, it was originally thought that the proper solution to this problem was to strengthen the die rings by increasing the wall thickness and overall weights thereof. Die rings designed in this manner also failed during the extrusion process as indicated above. A solution to this important problem, which forms the basis of this invention, was obtained by forming the die ring assembly in various component parts, which will presently be described.

One of the chief objects of this invention, therefore, is to provide a die ring assembly that can be uniformly preloaded in compression when it is pressed into a shrink ring assembly.

Another object of this invention is to provide a die ring construction that will possess a more uniform cross-section which will minimize stress concentrations and combined stresses due to abrupt changes in the inner ring wall configuration.

It is still a further object of this invention to provide a die ring asssembly composed of a die ring and an outer

sleeve that can be uniformly pre-loaded and which is free of combined stresses of high magnitude.

Still a further object of this invention is to provide a die ring in which its lower portion can be given a greater initial pre-loading than the upper portion thereof by means of an outer sleeve, and which will make the total pre-loading more uniform after the die ring assembly is pressed into the shrink ring assembly.

Even still another object of this invention is to provide new types of die rings that can be successfully employed to produce products that have fine surface finishes, close tolerances, thinner wall sections and improved physical characteristics. This invention is not limited to such uses, however.

Another object of this invention is to provide an improved die ring assembly which is simple and economical to manufacture, accurate and reliable in operation, and finally which is inexpensive to maintain and replace.

This invention briefly, therefore, pertains to a composite die ring assembly that has been designed in two parts, such that the bore of an outer ring or sleeve or first part is made to such a dimension that the inner ring or second part is initially pre-loaded before the die ring assembly is pressed into the shrink ring assembly, and which can be uniformly pre-loaded in the shrink ring assembly.

These and other objects of our invention as may hereinafter appear will be best understood from a description of accompanying drawings, which illustrate a preferred embodiment thereof, and form a part of this application, in which:

Fig. 1 is a sectional view of a conventional type of forward extrusion die ring taken through the longitudinal axis thereof;

Fig. 2 is a sectional view of a preferred embodiment of the invention and taken through the longitudinal axis of the die ring assembly;

Fig. 3 is a top plan view of the cnventional die ring construction illustrated in Fig. 1 with the die pilot and die punch removed;

Fig. 4 is a top plan view of the preferred embodiment of the die ring assembly shown in Fig. 2;

Fig. 5 is a longitudinal sectional view of a conventional die ring showing failure or rupture in the transverse direction; and

Fig. 6 is a longitudinal sectional view of a design of the conventional die ring shown in Fig. 5 and showing failure or rupture thereof in the longitudinal direction.

The composite die ring which comprises our invention is shown in the drawings in a preferred embodiment, although it is to be understood that departures from the construction shown in the drawings can be made without departing from our inventive concept.

Referring now to Fig. 1, reference numeral **10** refers generally to a conventional type of forged hollow die ring formed in a single construction and having integral therewith, at an intermediate inner portion of the ring, an extrusion shoulder **12**. Die ring **10** can be adapted for either forward, backward, or forward-backward extrusion of metal workpieces. However, it is used primarily for forward extrusion of metal workpieces.

For normal working stresses, die rings of this type are satisfactory. However, for stresses in excess of normal, this type of die ring cannot be pre-loaded uniformly in a shrink ring assembly (not shown) due to the varying resistance that is offered by the differences in die ring wall thickness. It will be noted that die ring **10** has a greater wall thickness at the bottom portion **14** than at the top portion **16**, with the wall thickness increasing from the top portion of the die ring to the bottom portion thereof.

In addition to the disadvantage mentioned above for the conventional die ring, there is another important disadvantage due to the sudden change of shape that occurs at the extrusion shoulder **12**. Here, complex stresses, of large magnitude, are concentrated at the juncture portion

18 located between the extrusion shoulder portion **12** and the upper portion **16** of die ring **10** whenever metal tubing or the like, as shown at **20**, is being extruded by means of the die pilot and punch illustrated at **22**.

These stress concentrations act as centers or nuclei of cracks that continue to propagate progressively either transversely along the juncture portion **18** or longitudinally from the juncture portion **18** at the inner surface **24** of die ring **10**. Eventually a failure or rupture of the die ring will occur. Conventional ring dies, similar to the one shown in Fig. 1, and which have failed either in the transverse or longitudinal direction because of these high stress concentrations in the vicinity of the upper portion of the extrusion shoulder, are illustrated in Figs. 5 and 6, respectively. In order to eliminate these initial centers of failure and also to provide a die design by which it is possible to make a die assembly which can be more uniformly preloaded when pressed into a shrink ring assembly, a composite die ring assembly has been designed.

A preferred embodiment of our invention is shown in Fig. 2. The die ring assembly has been made in two parts, namely, a tubular die ring **26** and an outer ring or sleeve **28**, with the configuration of the two combined being the same as the conventional type die ring shown in Fig. 1. The inner ring **26** has been designed with substantially a constant wall thickness throughout its length. The portion **32** of the die ring **26** below an extrusion shoulder **30** has been offset from the portion **34** thereabove in order that the die ring will have a uniform wall thickness throughout for a more uniform preloading of the die ring.

Die ring **26** has an annular cutout formed in this lower portion **32** because of the uniform wall thickness thereof. This cutout begins at **36**, which would lie substantially in a transverse plane passing through the juncture of the extrusion shoulder **30** and the upper portion **34** of the die ring, and extends to the lower surface **38** of the die ring **26**. The outer surface **40** of the lower portion **32** is a cylinder of revolution, with its axis coincident with the longitudinal axis of the die ring assembly, except that at **42** it is arcuate, the purpose of which is to eliminate abrupt changes in configuration and thus relieve possible regions or nuclei of stress concentrations during the extruding operation.

The extrusion shoulder **30** is located at an intermediate inner portion of the inner ring or sleeve **26**. The surface of the extrusion shoulder forms an angle that varies according to the die design required.

The outer ring or sleeve **28** is located around the bottom portion **32** of die ring **26**, and in the annular cutout formed by making the lower portion **32** of the same wall thickness as the upper portion **34**. The bore of sleeve **28** is made to substantially the same configuration as surfaces **40** and **42** but of slightly less diameter. Sleeve **28** is shrunk on lower portion **32** so that the latter will be given a greater initial pre-loading than the upper portion **34**. This arrangement allows for the total pre-loading to be more uniform after the die assembly is pressed into a shrink ring assembly.

While in the foregoing, specific features have been described in connection with our invention, it is nevertheless to be understood that we do not limit ourselves thereto except as the appended claims define the invention in its broadest sense over the prior art.

We claim:

1. A composite die ring for use in a shrink ring assembly for the cold extrusion of steel and the like, comprising, a tubular die ring for the shaping of a metal workpiece to be extruded, said die ring having a substantially constant wall thickness, said die ring having an extrusion shoulder at an intermediate inner portion thereof and forming the outer surface of an orifice through which the metal is extruded over said shoulder during the extruding operation, said die ring below said ex-

trusion shoulder being offset radially inwardly from the portion of the die ring above said shoulder, and an outer sleeve shrunk on said lower offset portion of said die ring, whereby the lower offset portion of said die ring may be placed under compression so as to receive an initial preloading which when combined with the preloading effected when the composite structure is placed in the shrink ring assembly will provide substantially uniform preloading for the whole of the composite die ring.

2. A composite die ring for use in a shrink ring assembly for the cold extrusion of steel and the like, comprising, a tubular die ring for the shaping of a metal workpiece to be extruded, said die ring having a substantially constant wall thickness, said die ring having an extrusion shoulder at an intermediate inner portion thereof and forming the outer surface of an orifice through which the metal is extruded over said shoulder during the extruding operation, said die ring below said extrusion shoulder being offset radially inwardly from the portion of the die ring above said shoulder, and an outer

sleeve shrunk on said lower offset portion of said die ring, whereby the lower offset portion of said die ring may be placed under compression so as to receive an initial preloading which when combined with the preloading effected when the composite structure is placed in the shrink ring assembly will provide substantially uniform preloading for the whole of the composite die ring, the outer surfaces of said die ring and said sleeve being a continuation one of the other.

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