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METHOD OF MANUFACTURING EYELETS OF METALS
OF THE TUNGSTEN MOLYBDENUM CLASS
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1,838,749

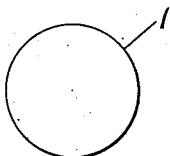


FIG. 1.

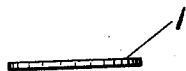


FIG. 2.



FIG. 3.



FIG. 4.

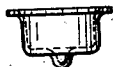


FIG. 5.



FIG. 6.



FIG. 7.



FIG. 8.



FIG. 9.



FIG. 10.



FIG. 11.



FIG. 12.

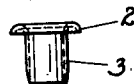


FIG. 13.

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METHOD OF MANUFACTURING EYELETS OF METALS OF THE TUNGSTEN-MOLYBDENUM CLASS

Application filed September 23, 1929. Serial No. 394,519.

This invention relates to the art of metal working and more particularly relates to the art of working refractory metals such as tungsten, molybdenum and the like, and has for its object the provision of a method of working said refractory metals into desired shapes other than rod, wire, filament, sheet and the like forms heretofore obtained.

Another object of this invention is to provide a shaped body of metal of the tungsten-molybdenum class.

Another object of this invention is to form sheet molybdenum into shaped bodies such as eyelets.

Another object of this invention is to provide a refractory eyelet material comprised of a metal of the tungsten molybdenum class.

Other objects and advantages will become apparent as the invention is more fully disclosed.

Heretofore in the art it has been customary to form eyelets of the more ductile metals and alloys such as, copper, iron, steel, nickel, aluminum and the like metals. In the working of such metals into eyelet form it is customary to impress upon a thin flat circular metal blank, a series of drawing or deformatory forces by means of a set of dies coacting and mechanically applied thereto in such manner as to gradually shape the blank to the desired configuration. Metals of the above mentioned class heretofore employed may be readily deformed in such manner at room temperatures and the finished eyelet usually retains sufficient workability so that it may be subsequently deformed in the usual eyeletting process without fracture.

With metals of the tungsten-molybdenum class it is not possible to apply the usual eyelet forming process heretofore employed. Metals of this class in the cold worked state possess what is known in the art as pseudo ductility, that is, an imparted ductility which is an unnatural condition of the metal.

Bodies or masses of the metals of this group are normally characterized by extreme brittleness at room temperatures, although it is commonly conceded that the individual grains of the metal mass possess high cold ductility. The brittleness of the mass is be-

lieved to be due to intergranular weakness.

In accordance with the principles set forth in U. S. Patent 1,082,933 issued December 30, 1913, to W. D. Coolidge, it is possible, by a suitable metal working process, to impart to this brittle mass of metal a degree of ductility at room temperature. The process in brief comprises an early hot working procedure followed by a cold working procedure at gradually reducing temperatures until ultimately the working temperature of the metal body approximates room temperature. As a result of this metal working process the individual crystals of the metal are mechanically deformed and elongated in the direction of working so that in effect the crystal structure of the metal body is altered to appear fibrous when examined under the microscope. The interlocking of the fibrous grains of the metal body is believed to overcome the natural brittleness or intergranular weakness of the metal mass imparting to the mass the necessary strength to resist the disrupting forces of cold work, or as is customarily defined in the art imparting thereto a condition simulating "ductility". "Ductility" in a metal is that property by virtue of which the same may be drawn out in tension without rupture, as through a die.

When heat is applied to the cold worked ductile body, and the temperature of the metal is raised above a temperature identified in the art as the recrystallization temperature, the cold worked fibrous grains of the metal tend to reorganize, or as is commonly called, to recrystallize, the fibrous condition of the metal body is lost and the initial brittle condition of the metal returns.

The above identified metal working process set forth in U. S. Patent 1,082,933 is directed primarily to the process of forming rod, wire and filament of ductile tungsten, but the essential principles set forth therein may be applied with equal success to the forming of sheet tungsten. Molybdenum is similar to tungsten metallurgically and the metal working principles applied to tungsten may be equally as well applied to molybdenum with modifications in the metal working tempera-

tures, drawing or rolling procedures, and the like factors to obtain the best results.

It is highly desirable to form from sheet tungsten or sheet molybdenum, shaped articles such as eyelets which may subsequently be employed in the arts. The present invention relates to a method by which such articles may be formed from sheet metal of tungsten and molybdenum.

Before further disclosing the nature of my invention reference should be had to the accompanying drawings, wherein

Figs. 1 to 13 inclusive illustrate the steps in the forming of eyelets from sheet metal of the tungsten-molybdenum class;

Fig. 1 is a plan view looking at the top of a blank of sheet metal from which the eyelet is made which in the present specific embodiment is comprised of molybdenum sheet metal;

Fig. 2 is a side elevational view of the same;

Fig. 3 is a side elevational view of the blank after it has been subjected to the first drawing operation;

Figs. 4, 5, 6, 7, 8, 9, 10 and 11 show side elevational views of the blank as it appears subsequent to the application of successive steps in the drawing operation;

Fig. 12 is a view of the finished eyelet looking at the top; and

Fig. 13 is a side elevational view of the finished eyelet.

In accordance with the objects of my invention I have found that in order to shape a cold worked mass of sheet tungsten or sheet molybdenum into a body such as an eyelet, which body may be capable of subsequently being mechanically deformed in a cold working step, such as is commonly known as eyeletting, that certain precautions which will be more fully hereinafter disclosed, must be observed.

I have found that in the shaping of molybdenum eyelets from sheet molybdenum, as an example, that the sheet metal body comprising the blank such as shown in Figs. 1 and 2 and which is to be subjected to the prescribed deforming steps such as indicated in Figs. 3 to 12 inclusive, must initially have imparted thereto certain physical characteristics which may be measured in terms of tensile strength, elastic limit, elongation, hardness and the like.

I have further found that to facilitate the deforming of the metal blank during the drawing operation and to insure the obtainance of a ductile product which is capable of subsequent deformation at room temperatures without fracture, annealing of the metal body during the deforming operation, must be employed. I prefer to apply the annealing during each deforming operation rather than at the conclusion of any one or any series of said deforming operations.

As a specific embodiment of the practice of my invention, I will disclose the method I employ in the forming of a molybdenum eyelet having the approximate size of 112 mil (.112 inches) length by 85 mil (.085 inches) diameter shank by about 140 mil (.140 inches) diameter collar.

This size eyelet is produced from a circular blank material of sheet molybdenum of approximately 245 mil (.245 inches) diameter by 8.4 (.0084 inches) to 8.8 mil (.0088 inches) thickness which is shown in Fig. 1. The sheet molybdenum from which this circular blank is made is rolled in the usual manner to the desired thickness and sufficient cold working is imparted thereto to give a sheet material which has a tensile strength in a section 12 inches long by 1 inch wide of approximately 100,000 pounds per square inch and an elongation in a 10 inch gauge length of about 6%.

It is preferable to so control the working procedure that the sheet material as it is rolled down to the desired thickness (.0086 inches) will have approximately 100,000 pounds per square inch tensile strength. If sheet material having a tensile strength in excess of this figure is obtained, suitable annealing of the metal at elevated temperatures to bring the tensile strength back to this desired figure, may be applied.

In the eyelet forming operation no material departure from the prior art is made in the mechanical process that has heretofore been employed in the forming of eyelets from cold ductile metals. The usual eyelet forming machines may be employed. The principle variation is made in the number of die steps employed. Molybdenum cold rolled to a tensile strength of about 100,000 pounds per square inch has a hardness as measured on the well known Ericson tester machine of between 1.32-1.50. It is necessary therefore to employ a greater number of deforming steps in the eyelet forming process than would otherwise be employed with the more ductile or cold plastic metals. The type of die and mode of application to the blank from which the eyelet is formed does not essentially differ from what heretofore has been employed in the art, and does not need illustrating or definition herein.

The circular sheet metal blank 1 is shaped or stamped in any convenient manner from the molybdenum sheet metal strip of the above identified physical characteristics, shown in Figs. 1 and 2 is first heated by any convenient means to a temperature approximating 200° C. and then is placed in position between the first set of drawing dies. The mechanical load is applied thereto and the first drawing operation upon the blank is made, the resulting product appearing as in Fig. 3.

The deformed blank is then re-heated to about 200° C. placed between the second set

of dies, the mechanical load applied thereto and the second drawing operation made giving a product as shown in Fig. 4.

This drawing process is repeated utilizing in all 10 sets of dies before the finished eyelet product having a rolled collar 2 and shank 3 as shown in Figs. 12 and 13 is obtained. The deforming blank is preheated before each drawing step to temperatures approximating 200° C.

The specific preheat temperature and the number of drawing operations that may be applied to the metal blank is dependent in part upon the physical characteristics of the sheet metal, such as the tensile strength, elastic limit, elongation, etc. and upon the extent of the deformation that may be applied to the metal blank in any one drawing operation. Such factors allow a wide latitude in the selection of materials, the annealing temperature applied thereto during working, the type of drawing applied in each step and the extent of deformation obtained therein at each die step. In the present instance starting with a material of the above tensile strength per square inch, the plasticity of the metal body is materially increased by heating to temperatures approximating 200° C. With different tensile strength material this preheat temperature may be varied somewhat but in general will always be below red heat.

The preheating of the metal blank during working prevents the development of excess amounts of work hardening as a result of the deforming operation, and a metal eyelet product is obtained which has sufficient cold plasticity remaining to be subsequently cold worked or deformed at room temperatures for a limited extent without fracture as in the customary eyeletting operating of uniting articles together.

In lamp and radio tube manufacture the use of eyelets comprised of highly refractory metal such as, molybdenum and tungsten, rather than eyelet material of lesser refractory but more ductile metal, such as iron, nickel, aluminium and the like, in the mounting and assembling of the metal elements of the lamps and radio tubes, offers advantages such as have heretofore been unobtainable.

Such advantages and the method of applying these refractory metal eyelets in the mounting and assembling of the metal elements of electron discharge devices is disclosed in my copending application Serial No. 394,518 filed September 23, 1929, entitled "Electrode assembly for electron discharge devices," which application is assigned to the same assignee as the present invention.

Having broadly and specifically disclosed the nature and scope of the present invention it is apparent that there may be many variations and departures from the specific embodiment disclosed herein without substan-

tially departing from the nature of the invention as set forth in the accompanying claims.

What is claimed is:

1. The method of forming eyelets of refractory metals of the tungsten-molybdenum class which comprises cold rolling said metal into sheet form of predetermined thickness, adjusting the tensile strength thereof to a predetermined desired figure, applying to sections of said sheet metal a series of deforming operations designed to ultimately shape said eyelet from said section of sheet metal, the sheet metal body being maintained during each deforming operation at elevated temperatures below red heat.

2. The method of forming refractory metal eyelets which comprises shaping said refractory metal into cold rolled sheets of the desired thickness, adjusting the tensile strength to a predetermined minimum figure, shaping circular blanks from said sheet metal, and applying to the circular blank a series of successively applied deforming operations by means of mechanically applied drawing dies designed to shape said blank to said eyelet, maintaining the deforming circular metal blank during the deforming operation at all times at temperatures above room temperature but below red heat.

3. The method of forming eyelets from sheet molybdenum which comprises cold rolling said molybdenum sheet to the desired thickness, adjusting the tensile strength to approximately 100,000 pounds per square inch when determined upon a strip of said sheet approximately one inch wide by 12 inches long, shaping therefrom circular blanks of the desired diameter, heating said blanks to elevated temperatures approximating 200° C. and applying to said heated blank a series of deforming operations by means of mechanically applied dies to shape said eyelet therefrom, the temperature of said metal blank being maintained throughout each deforming operation at said elevated temperatures of approximately 200° C.

In testimony whereof, I have hereunto subscribed my name this 19 day of September 1929.

WILLIAM F. DESTER.