Sept. 11, 1945. D. H. CRAVENER, JR., ET AL 2,384,444

METHOD OF FORMING COUNTERBORED RECEPTACLES

Filed June 19, 1942

Fig. 1

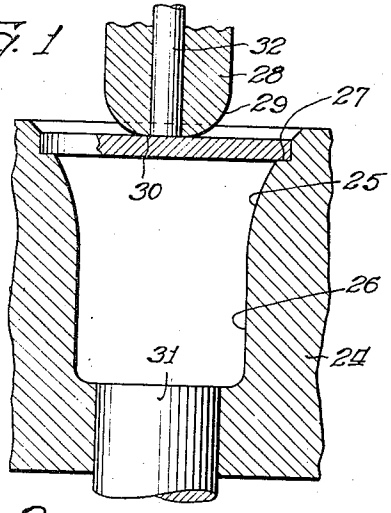


Fig. 2

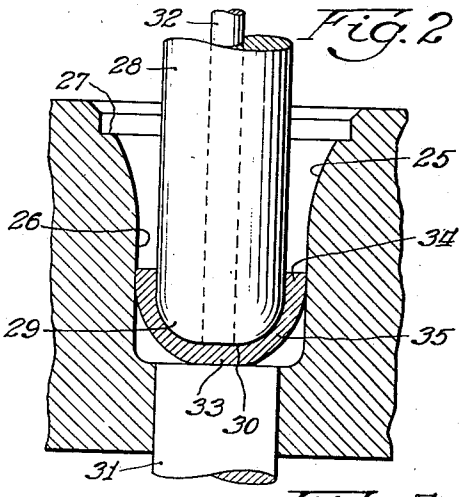


Fig. 3

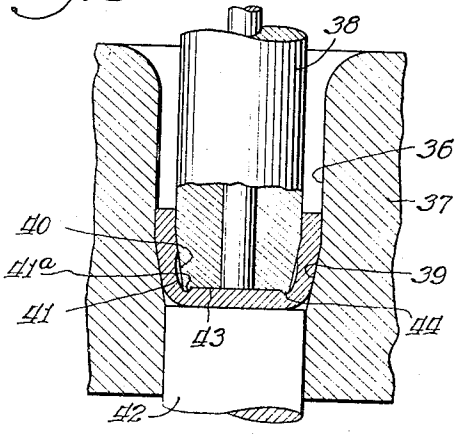


Fig. 4

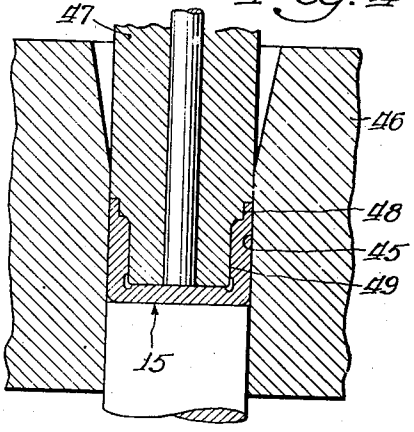
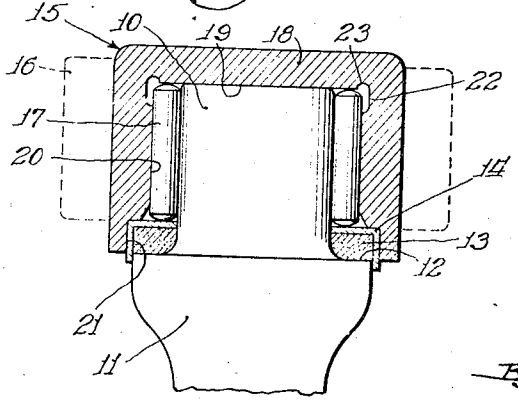


Fig. 5



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METHOD OF FORMING COUNTERBORED RECEPTACLES

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4 Claims. (Cl. 29—148.4)

This invention relates to a method of forming a counterbored receptacle. By way of example this invention will be described with reference to a method of forming a trunnion bearing for a universal joint.

Certain mechanical devices such as trunnion bearings are required to have a cylindrical shape with one end of the cylinder closed off and with a counterbored portion near the closed end. The counterbore is required whenever the inside of the device is to be ground or otherwise finished so that the finishing tool may have a space in which to run out. Where such devices are of relatively large size, they may be formed readily from flat stock by means of dies, the counterbored section being formed by an appropriately designed expanding die. Where the device is small, however, as is the case of a trunnion bearing, there is not sufficient room within the device for a sturdy and practical expanding die, and for this reason such small devices are generally produced from solid bars which are drilled out, and counterbored in a screw machine. The latter method is of course wasteful since the material drilled out is useless, and it is also a longer process.

The principal object of this invention is to provide a method of forming relatively small receptacles having a counterbore at or near the bottom thereof wherein the receptacle is made from flat stock and without the use of a screw machine.

A more specific object of this invention is to provide a method of making a trunnion bearing for a universal joint, the method employing only the ordinary solid punches and dies.

Another specific object of this invention is to provide a method of controlling the flow of metal in a blank such that although adjacent sections of the metal are acted upon by substantially the same force, one section will move while the other will remain stationary.

These and other objects and features of this invention will become apparent from the following description when taken together with the accompanying drawing in which:

Fig. 1 is a fragmentary section taken through two portions of a die showing the die in its open position and about to perform the first operation upon a blank;

Fig. 2 shows the same die after the operation is completed;

Fig. 3 shows a second die performing the second operation upon the blank;

Fig. 4 is a fragmentary section through a third die showing the final step in the method; and

Fig. 5 is an enlarged fragmentary section through a trunnion bearing for a universal joint made by the method of this invention.

Referring first to Fig. 5 for a description of the receptacle or trunnion bearing, 10 is a journal of a cross member 11 of a universal joint, said cross member being formed with a shoulder 12 against which is pressed a packing ring 13 which is held in place by a flanged washer 14. Said journal 10 operates within a trunnion bearing 15 which is held in one fork 16 of a yoke member which in turn is secured to one of the shafts (not shown) in the power train. Anti-friction rollers 17 are inserted between trunnion bearing 15 and journals 10 to reduce the friction therebetween.

Trunnion bearing 15 is in the form of a cylinder having one end 18 closed and formed integrally therewith. The purpose of this construction is to prevent lubricant from being thrown out from the bearing as the joint is rotated. The end of journal 10 bears against surface 19 of closed end 18 as do also the ends of rollers 17. Rollers 17 roll on a surface 20 on the inside of the cylindrical portion of trunnion bearing 15. Washer 14 is pressed into a recess 21 in the open end of the trunnion bearing.

It will be observed that surfaces 19 and 20 must be finished off and surface 20 must be ground perfectly true. In order that these finishing operations may be performed it is necessary that the inside corner of the bearing be relieved to provide a run-out for the finishing tool. For this reason surface 20 is counterbored at 22 and a small groove is provided at 23 which brings into relief surface 19. Thus a tool passing across surface 20 may run out into the counterbore 22 and a tool moving across surface 19 may run out into groove 23.

It is obvious that the formation of trunnion bearing 15 from a round bar by means of drilling and counterboring tools may readily be accomplished but that if the bearing is to be formed by means of dies alone the counterbore 22 and groove 23 present a problem. Surface 20 is cylindrical and any die which is used to form counterbore 22 must be able to contract into the diameter of surface 20 if it is to be withdrawn from the bearing. Such a die however, cannot be made sturdy enough where the bearing is of the size normally used in present day pleasure automobiles. The method by which we have solved this problem will now be described.

The first step in our method is the formation of a disc-shaped blank from flat stock, the thickness and diameter of the blank being determined ac-

cording to the final dimensions of the trunnion bearing.

Next the disc-shaped blank is placed into a die as shown in Fig. 1. The die is comprised of a female member **24** having a flared opening **25** which merges into a cylindrical section **26**. A shoulder **27** is provided for properly centering the blank in the die. The male member **28** is provided with a rounded corner **29** and a flat end **30**. Suitable knock-out pins **31** and **32** are provided in both portions of the die as is customary.

Fig. 2 shows the blank after it has been operated upon by the die shown in Fig. 1. It will be observed that the blank is thicker at the bottom portion **33** and at the open end portion **34** and is thinner at the corner portion **35**. This is done deliberately and no effort is made to make the corner portions **35** the same thickness as the remainder of the blank. It is important in this first operation that the metal is not caused to work-harden to any appreciable extent and for this reason the corner region **35** is not formed against the female member of the die.

The next operation is shown in Fig. 3. In this operation the blank is forced into a cylindrical opening **36** in the female portion **37** of the die by the male member **38** thereof. Opening **36** is of substantially the same diameter as the cylindrical portion **26** of the preceding die but it is tapered at **39** to a smaller diameter which corresponds to the diameter of the finished trunnion bearing. This taper permits groove **41***a* to be formed in the blank by a simple reciprocating die, the wider opening in the blank permitting the die to enter and leave the blank freely. Male member **38** has a corresponding taper **40** in the end thereof which forces a portion of the blank against the tapered portion **39** of opening **36**. Due to the thinning of the material at the corner in the preceding operation the pressure on the blank at the tapered region is very small and in fact a portion **41** of the blank remains untouched. This definitely prevents the material at the tapered region from work-hardening and leaves it sufficiently ductile to withstand a further change in form.

The bottom of the blank however is pressed against a knock out pin **42** by the end of male member **38**, said end having a flat surface **43** which is joined to the taper **40** by means of a bead **44**. Said bead **44** is pressed into the blank so that the latter is coined and is work-hardened thereat. This work-hardening is limited to just that portion of the blank which is operated upon by the bead **44**. Since this portion is work-hardened, it will resist further change in shape and, given an equal pressure acting upon the work-hardened portion and upon those portions immediately adjacent thereto, the latter will flow whereas the former will not. This controlled work-hardening of the material is an important feature of our method.

The last operation is shown in Fig. 4. In this operation the blank of Fig. 3 is forced into the opening **45** of the female portion **46** of a die, the opening being cylindrical and being of the same diameter as the finished trunnion bearing. Since this diameter is smaller than the diameter of the open end of the blank as it leaves the preceding die, the sides of the blank are necessarily forced radially inwardly against the male member **47** of the die. Said male member **47** has an outer diameter which fits snugly into the opening **45** and is also provided with a shoulder **48** and a section of reduced diameter **49**, both of which are approximately of the finished dimension. Reduced portion **49** is slightly smaller in diameter than the diameter of the finished bearing since allowance is made for a light grinding cut which must be taken in order to finish the bearing. The shoulder in male member **47** contributes considerable axial pressure which causes the sides of the blank to move axially to reduce the radius of the corner of the blank. Thus the sides are moved axially toward the bottom of the bearing and are also moved inwardly against the male member, and in so moving, there is a tendency to pile up the metal in the inner corner of the blank. Since this region was work-hardened in the preceding step, this "piling up" tendency is resisted and as a result a counterbore is formed in the corner. This of course is exactly what is desired and the blank may then be finished off on the inside without any difficulty.

The foregoing method provides a closed receptacle with a counterbore therein which is very accurately made and which requires little machining. It can be made with ordinary punch presses using standard multiple die apparatus so that the complete receptacle can be formed in a single press. Although the method has been described with reference to the making of a trunnion bearing for a universal joint it is understood that the method has a wider application and that it can be used generally wherever a device similar to the trunnion bearing in size and configuration is to be made. It is understood therefore that the scope of the invention is not limited to the foregoing description but is to be determined by the appended claims.

We claim:

1. The method of forming a trunnion bearing for a universal joint, said bearing comprising a cylinder closed at one end and counterbored at the inside bottom region to provide a run-out for a finishing tool, said method comprising forming into the shape of a cup an imperforate disc-shaped blank by means of a round nosed punch operating in a cylindrical die such that the bottom of the blank is not work-hardened at the bottom corner region thereof, work hardening a circular region constituting a part of said bottom corner region and inside the blank, said circular region being of lesser diameter than the inside diameter of the open end of the blank, and then reducing the diameter and length of the blank against a cylindrical punch, the reduced inside diameter being smaller than the greatest diameter of the work-hardened region, whereby to form the counterbore in the blank, the work-hardening of the circular region being accomplished by coining the bottom of the blank.

2. The method of forming a trunnion bearing for a universal joint, said bearing comprising a cylinder closed at one end and counterbored at the inside bottom region to provide a run-out for a finishing tool, said method comprising forming into the shape of a cup an imperforate disc-shaped blank by means of a round nosed punch operating in a cylindrical die such that the bottom of the blank is not work-hardened at the bottom corner region thereof, work hardening a circular region constituting a part of said bottom corner region and inside the blank, said circular region being of lesser diameter than the inside diameter of the open end of the blank, and then reducing the diameter and length of the blank against a cylindrical punch, the reduced inside diameter being smaller than the greatest

diameter of the work-hardened region, whereby to form the counterbore in the blank, the cupping resulting in a blank wherein the bottom and side walls are thicker than the corner region therebetween, and the reduction in the length of the blank being accomplished by upsetting the corner regions.

3. The method of forming a trunnion bearing for a universal joint, said bearing comprising a cylinder closed at one end and counterbored at the inside bottom region to provide a run-out for a finishing tool, said method comprising forming into the shape of a cup an imperforate disc-shaped blank by means of a round nosed punch operating in a cylindrical die such that the bottom of the blank is not work-hardened at the bottom corner region thereof, work hardening a circular region constituting a part of said bottom corner region and inside the blank, said circular region being of lesser diameter than the inside diameter of the open end of the blank, and then reducing the diameter and length of the blank against a cylindrical punch, the reduced inside diameter being smaller than the greatest diameter of the work hardened region, whereby to form the counterbore in the blank, the work-hardening of the circular region being accomplished by coining a groove in the inside bottom of the blank to provide a run out for a finishing tool operating thereacross.

4. The method of forming a trunnion bearing for a universal joint, said bearing comprising a cylinder closed at one end and counterbored at the inside bottom region to provide a run-out for a finishing tool, said method comprising forming into the shape of a cup an imperforate disc-shaped blank by means of a round nosed punch operating in a cylindrical die such that the bottom of the blank is not work-hardened at the bottom corner region thereof, work hardening a circular region constituting a part of said bottom corner region and inside the blank, said circular region being of lesser diameter than the inside diameter of the open end of the blank, and then reducing the diameter and length of the blank against a cylindrical punch, the reduced inside diameter being smaller than the greatest diameter of the work-hardened region, whereby to form the counterbore in the blank, and effecting simultaneously with the reduction in length the finishing of the end of the blank to form a shoulder therein.

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