May 29, 1962 B. E. RICKS 3,036,366

METHOD OF MAKING BALL STUDS

Filed Dec. 23, 1957

Fig. 1

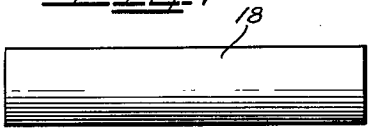


Fig. 2

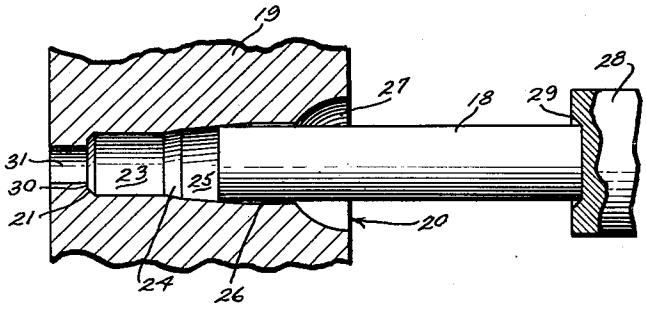


Fig. 3

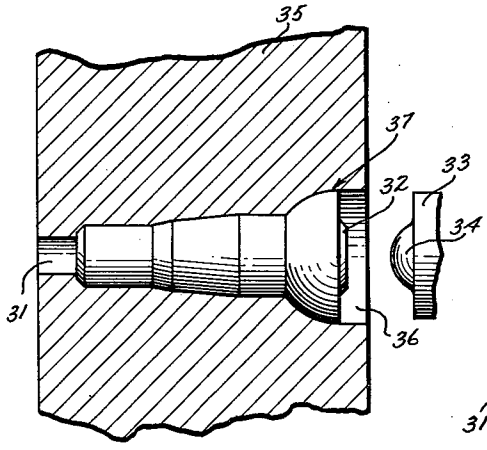


Fig. 4

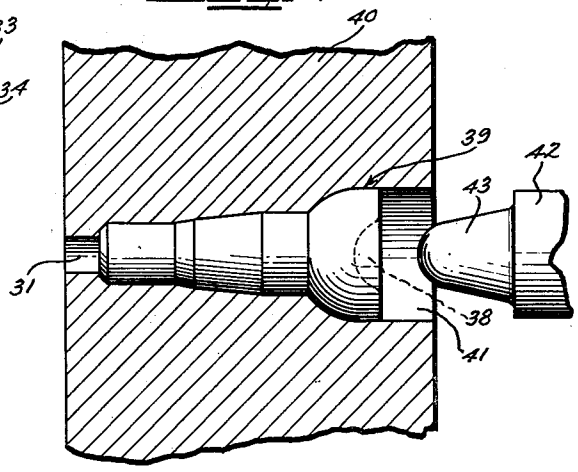


Fig. 5

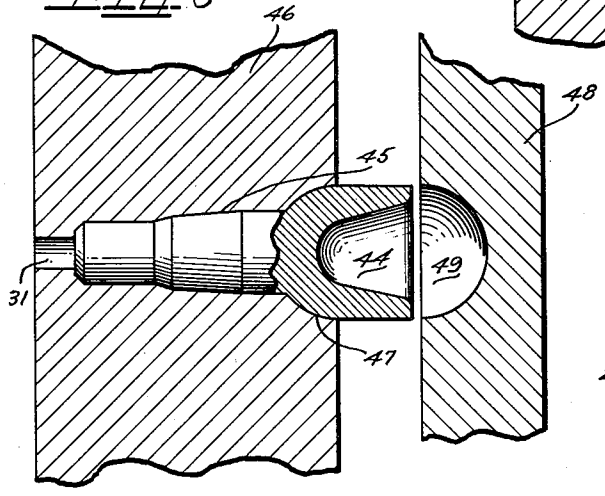
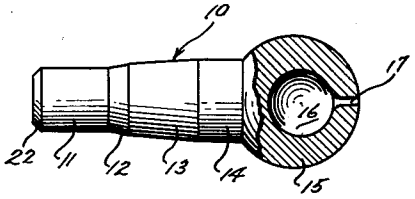


Fig. 6



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METHOD OF MAKING BALL STUDS

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The present invention relates broadly to the art of metal forming, and is more particularly concerned with a new and improved method of making ball studs by punch and die extrusion techniques.

Current production methods in the forming of ball studs require relatively expensive and time consuming lathe cutting steps. Applicant, however, has discovered that a superior article may be provided by utilizing punches and dies to successively shape a blank into a finished stud. Briefly stated, the present method comprises providing a blank of predetermined diameter and length from coil stock or the like, locating the blank in alignment with a die having a cavity corresponding to the outer shape of the final stud with the exception of the entire head thereof, and directing against one end of the blank a first punch to provide upon said blank the stem, taper, shank and portion of the head ultimately desired. At least one additional punch is then directed at the center of the partially shaped head to form a thimble-shaped cavity therein, and this is followed by use of a die having a concave cavity which forms the stud head into the desired ball-shaped configuration. The thimble-shaped recess is thereby converted into an essentially round inner cavity in the head, providing a lubricant reservoir for the tie rod socket or other structure within which the ball stud is normally received.

It is therefore an important aim of the present invention to avoid the disadvantages of prior art processes by the provision of a ball stud forming method which may be accomplished with a limited number of punches and dies utilizing a relatively few readily performed steps.

Another object of the invention is to provide a method of making ball studs which may be performed utilizing existing punch press or cold header equipment, and does not require the relatively expensive and time-consuming earlier steps of blanking, machining and grinding.

Another object of the invention lies in the provision of a ball stud forming method which speedily and effectively produces a superior product having a permanently lubricated reservoir therein.

A further object of the present invention is to provide a novel method of making ball studs which does not require a final finishing operation, and which comprises first forming upon a blank of predetermined size, the stem, taper, shank and portion of the head thereof, producing in the head a generally thimble-shaped cavity, and forming the exterior of the head portion into the ball-shaped configuration desired.

Other objects and advantages of the present invention will become more apparent as the description proceeds particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals are employed to designate like parts throughout the same.

FIGURE 1 is a view of a typical blank from which the finished ball stud may be formed;

FIGURE 2 is a sectional view of a first forming die showing the stud blank being directed therein by the first punch member;

FIGURE 3 is a sectional view of a second die showing the partially formed ball stud as produced by the step of FIGURE 2 and prior to initial formation of a head cavity and further shaping of the head by the punch member of FIGURE 3;

FIGURE 4 is a sectional view of a third die showing a relatively shallow concave head cavity as provided by the step of FIGURE 3 and prior to further shaping of the head and cavity therein by the punch member of FIGURE 4;

FIGURE 5 is a sectional view of a fourth die showing the ball stud head as formed by the step of FIGURE 4, and a female die member which may be utilized to shape the ball stud head into the final round configuration; and

FIGURE 6 is a view partially in section, of the finished ball stud showing the head cavity and passage thereto as formed by the step of FIGURE 5.

Referring now to the drawings, and initially first to FIGURE 6 thereof, a full ball stud **10** as produced in accordance with this invention comprises a stem **11** of generally uniform diameter which ultimately may be threaded by cutting or rolling, and one or more tapered portions **12** and **13** having diameters greater than that of the stem **11**. Integral with the tapered portions is a shank **14** of generally uniform cross-section throughout its length and upon which an integral head **15** is received. The head is generally circular in cross-section, as shown, and is provided interiorly thereof with a substantially round cavity **16** connecting with a slender open-ended passage **17** located in generally the center of the top of the head portion. The passage **17** provides a flow path for lubricant into and out of the cavity **16**, and said cavity thereby constitutes an effective grease reservoir that can be drawn upon throughout the life of the tie rod socket or other structure with which the ball stud **10** is associated. When ball studs are manufactured by customary lathe cutting operations, the head of a ball stud is completely closed, and provision of the cavity **16** provides a means by which the life of the tie rod socket or other structure may be substantially increased.

As indicated previously, it has heretofore been customary in the art to form full ball studs by a series of relatively expensive and time-consuming steps of blanking, machining and grinding the part from bar stock in which much time and material is wasted in the long cuting operation. Applicant has discovered that much time can be saved and a more effective article produced by moving the metal rather than cutting the same. Turning now to FIGURE 1, the first step in the present process is the provision of a length of blank material which may be cut continuously from coil stock to the desired diameter and length. Designated as **18**, the blank is then located adjacent and in alignment with a die **19** having the internal configuration shown. Within the die there is provided a cavity designated in its entirety by the numeral **20**, and corresponding to the outer shape essentially of the ball stud **10**, with the exception of the ultimate head portion **15** thereof. Specifically, the cavity includes a beveled shoulder **21** against which is formed the beveled end **22** on the stud **10**, and a section **23** of relatively uniform diameter which provides when the blank **18** is extruded thereagainst the stem **11** of the stud. Outwardly of the cavity **20** from the section **23** are tapered sections **24** and **25** which form the portions **12** and **13** on the stud. It will, of course, be appreciated that for certain applications in practice only a single taper on the stud is required, and accordingly, the die cavity design would be suitably modified to take this into consideration.

Corresponding in outer diameter to the shank **14** is a section **26** of the cavity, and at the outer or upper end of the cavity **20** is a section **27** of semi-circular shape in cross-section corresponding in radius to approximately the lower half portion of the fully rounded head **15**, shown in FIG. 6.

The blank **18** need not be heated prior to insertion into the die cavity **20**, or prior to the succeeding steps and

the cold heading or cold extruding made possible by this invention was quite unforeseeable. Thus, heretofore it was believed that forward and backward extrusion, in a cold heading die, was impossible to achieve. Yet the present invention produces such movement of metal without either heating the die or the metal.

A punch **28** having a recessed portion **29** at one end thereof is preferably employed to extrude the blank **18** into the desired initial shape, and upon completion of full travel of said punch **28**, there is formed the beveled end **22**, stem **11**, tapers **12** and **13**, shank **14** and approximately one-half of the head **15** shown in FIG. 3 in the partially formed condition. In addition, when the blank **18** is driven completely into the cavity **20**, the extent of which at one end is a shoulder **30** adjacent the knockout hole **31** of the die, there is provided on the partially shaped head portion of the stud a raised portion **32** corresponding to the slightly concave recess **29** in the punch head **28**. The recess in said first punch could of course be eliminated; however, its use has been found desirable in actual practice in order to assist in controlling sideward movement of the blank **18**, and is preferred for this and other reasons.

Upon completion of the step shown in FIGURE 2, the stem, taper and shank portions are essentially finally formed. To then further shape the head into its ultimate fully round configuration, a punch **33** having a convex shaping surface **34** may be employed. A die **35** having a somewhat deeper head cavity **36** is preferably provided, and after location therein of the partially formed stud **37** from FIGURE 2, the punch **35** is driven forwardly and against the raised portion **32**. There is formed by this action a generally concave recess **38**, as shown in FIGURE 4, and which corresponds to the convex shaping surface **34** on the punch **33**.

To further shape the head of the partially formed stud **39** from FIGURE 3, said stud is preferably located in a die **40** (FIGURE 4) which differs from the die **35** in the increased depth of its head cavity **41**. A punch **42** having a shaping surface **43** of generally thimble-shaped configuration is then moved forwardly into the cavity **41** and into the head recess **38** provided therein by the step of FIGURE 3. As the shaping surface **43** of the punch **42** continues forwardly into the partially shaped head of the stud **39**, the head material surrounding said shaping surface is forced outwardly in the head cavity **41** of the die **40** in contact with the walls thereof. Upon reaching the end of travel of the punch **42**, the head portion of the stud **39** is provided therein with a thimble-shaped cavity **44**, as appears in FIGURE 5, said cavity conforming to the curvature of the shaping surface **43**.

To accomplish the final forming step of FIGURE 5, in which the head is shaped into its fully round or ball-shaped configuration, the stud shape **45** from the step of FIGURE 4 may be transferred to a die **46** having a head section cavity **47** which is of lesser depth than the cavity **41** of die **40**. While supported in said die **46**, there is directed against the stud-shape **45** a female die **48** having a substantially concave shaping surface **49** provided therein. As relative movement between the dies **46** and **48** occurs, the outer walls of the partially shaped head are in effect surrounded by the shaping surface **49** of the die **48**, and caused to roll radially inwardly thereon. This transforms the generally thimble-shaped cavity **44** of the shape **45** into a substantially round cavity **16** as appears in the finally shaped ball stud of FIGURE 6.

Apparatus of varying types may be employed with the dies and punches shown in the drawings to expeditiously form the full ball stud of FIGURE 6. As for example, a progressive three-blow cold header having three working blows in addition to the cutoff mechanism could be employed to practice the steps of FIGURES 2, 3 and 4. Final shaping of the head, as shown in FIGURE 5, could then be performed as a secondary operation with a second single blow cold header, or a punch press, either of which could be automatically hoppered for continuous operation. On the other hand, a cold header provided with an oscillating head which permits two punches of different form to alternately strike the same die could be effectively utilized. Thus, utilizing the combination of a progressive header, that is, a three-blow machine, with an oscillating head, it would be practical with one machine to perform each of the steps shown in FIGURES 2 through 5. As, for example, punches **28** and **33** could alternately strike the blank **18** which would remain in die **19** and the progressive operation continued to die **40** and punch **42**, and then to the final finishing operation employing dies **46** and **48**. It will thus be appreciated that the step of FIGURE 3 may not at all times be required, and that formation of the ball stud **10** may be effectively accomplished only by the steps of FIGURES 2, 4, and 5. In addition, by the provision of die inserts, it is believed possible to use only a single master die.

It may now be seen that applicant has provided a novel method of making full ball studs which may be speedily and effectively accomplished with the minimum amount of equipment. The final product as produced by the steps herein disclosed has the important advantage of permanent lubricating properties not possessed by prior art structures, and the steps performed in providing such an article are considerably fewer in number and less laborious than methods heretofore practiced. A relatively small number of simply constructed dies and punches may be employed, and the earlier expensive steps of blanking, machining and grinding are no longer required. Further, the method of this invention is much more readily adapted to mass production techniques with resulting substantial economies.

It is to be understood that the form of the invention herein disclosed and described is to be taken as the preferred embodiment of the same, and that various changes in the size, shape and arrangement of parts may be practiced without departing from the spirit of the invention or the scope of the subjoined claims.

I claim as my invention:

1. A method of making ball studs, comprising providing a blank of predetermined length and diameter, first forming upon said blank stem, taper and shank portions and a substantially semi-circular head portion, then restraining said head portion against movement in one direction while displacing the central portion of said head portion in an opposite direction to form therewithin a generally thimble-shaped cavity, and next applying a shaping force to the exterior of the head portion to form said head portion into a substantially round ball shape having interiorly thereof a generally circular cavity.

2. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising providing an unheated blank of predetermined length and diameter, first forming upon said cold blank within a die having a stepped cavity the stem, taper and shank portions and a substantially semi-circular head portion, then restraining said head portion against movement in one direction while displacing the central portion of said head portion in an opposite direction to form therewithin a substantially thimble-shaped open-ended cavity, and next forming the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

3. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising providing an unheated blank of predetermined length and diameter, first forming upon said cold blank within a die having a stepped cavity the stem, taper and shank portions and a substantially semi-circular head portion, then restraining said head portion against movement in one direction while displacing the central portion of said head portion in an opposite direc-

tion to form therewithin a thimble-shaped cavity open at one end thereof, and next essentially entirely closing said cavity by forming the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity and a passage leading thereto.

4. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising forming a cold blank of predetermined length and diameter, first forming upon said cold blank the stem, taper and shank portions and a substantially semi-circular head portion, then forming a substantially concave recess within the head portion generally centrally thereof, next restraining said head portion against movement in one direction while displacing the central portion of said head portion in an opposite direction to form therewithin a generally thimble-shaped open-ended cavity, and thereafter forming the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

5. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising providing a substantially cylindrical blank of predetermined length and diameter, directing a first punch member against one end of said blank to force said blank entirely within a die having a cavity of varying diameter to form thereon the stem, taper and shank portions and a substantially semi-circular head portion, restraining said head portion against movement in one axial direction while directing a second punch member against said head portion to displace the central portion of said head portion in an opposite axial direction forming therewithin a generally thimble-shaped cavity open at one end thereof, and directing against said head portion a die member having a generally concave shaping surface to form the head portion into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

6. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising providing a substantially cylindrical blank of predetermined length and diameter, directing a first punch member against one end of said blank to force said blank entirely within a die having a cavity of varying diameters to form thereon the stem, taper and shank portions and a substantially semi-circular head portion, moving a second punch member against said head portion generally centrally thereof to form a concave recess therein, restraining said head portion against movement in one axial direction while directing a third punch member into the concave recess to displace the central portion of said head portion in an opposite axial direction forming therewithin a generally thimble-shaped cavity, and directing against said head portion in surrounding relation thereto a die member having a generally concave shaping surface to form the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

7. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising forming a substantially cylindrical blank of predetermined length and diameter, directing a first punch member against one end of said blank to force said blank entirely within a die having a cavity of varying diameters to form thereon the stem, taper and shank portions and a substantially semi-circular head portion, locating the partially shaped stud in a die having a cavity conforming at one end to the outer diameter of the substantially semi-circular head portion but of greater depth than the length of said head portion for restraining said head portion against movement in one axial direction, moving a second punch member against said head portion to displace the central portion of said head portion in an opposite axial direction and to form therein a generally thimble-shaped open-ended cavity, and directing against said head portion in surrounding relation thereto a die member having a generally concave shaping surface to form the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

8. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising providing substantially cylindrical blank of predetermined length and diameter, directing a first punch member against one end of said blank to force said blank entirely within a die having a cavity of varying diameters to form thereon the stem, taper and shank portions and a substantially semi-circular head portion, locating the partially shaped stud in a die having a cavity conforming at one end to the outer diameter of the substantially semi-circular head portion but of greater depth than the length of said head portion for restraining said head portion against movement in one axial direction, moving a second punch member against said head portion to displace the central portion of said head portion in an opposite axial direction and to form therein a generally thimble-shaped open-ended cavity, supporting the partially shaped stud in a die with the head portion extending partially outwardly therefrom, and directing against said head portion in surrounding relation thereto a die member having a generally concave shaping surface to form the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

9. A method of making a ball stud provided with a generally round head and shank, taper and stem portions of lesser diameters, comprising forming a substantially cylindrical blank of predetermined length and diameter, directing a first punch member against one end of said blank to force said blank entirely within a die having a cavity of varying diameters to form thereon the stem, taper and shank portions and a substantially semi-circular head portion, locating the partially shaped stud in a die having a cavity conforming at one end to the outer diameter of the substantially semi-circular head portion but of greater depth than the length of said head portion for restraining said head portion against movement in one axial direction, moving a second punch member against said head portion to displace the central portion of said head portion in an opposite axial direction and to form therein a generally thimble-shaped open-ended cavity, supporting the partially shaped stud in a die with the head portion extending partially outwardly therefrom, and directing against said head portion in surrounding relation thereto a die member having a generally concave shaping surface to turn the walls of the head portion radially inwardly and form the head into a substantially round ball shape having interiorly thereof a generally circular lubricant cavity.

10. In a method of forming a ball stud from a metal rod of constant cross-section initially, the steps of forming a segmental spherical head portion at one end thereof, restraining said head poriton against movement in one direction while displacing a central portion of said head portion laterally and axially in an opposite direction to form an extended wall portion, and die forming said extended wall portion to a generally spherical contour complementing the segmental spherical contour of said head portion.

11. In a method of forming a ball stud from a metal rod of constant cross-section initially, the steps of forming a segmental spherical head portion at one end thereof, displacing a central portion of said head portion laterally and axially in one direction while confining the segmental spherical surface of said head portion against movement an an opposite axial direction to form an extended wall portion, and die forming said extended wall portion to a generally spherical contour complementing the segmental spherical contour of said head portion.

12. In a method of forming a ball stud from a metal rod of constant cross-section initially, the steps of forming a segmental spherical head portion at one end thereof, supporting said head portion against movement in one axial direction while directing a punch member into said segmental spherical head portion and displacing a central portion of said head portion laterally and axially in an opposite direction to form a generally cylindrical extended wall portion, and die forming said extended wall portion to a generally spherical contour complementing the segmental spherical contour of said head portion.

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