

March 18, 1947.

H. T. M. RICE

2,417,569

METHOD OF AND APPARATUS FOR PRESS FORGING
WRENCH SOCKETS AND THE LIKE

Filed Aug. 29, 1944

6 Sheets-Sheet 1

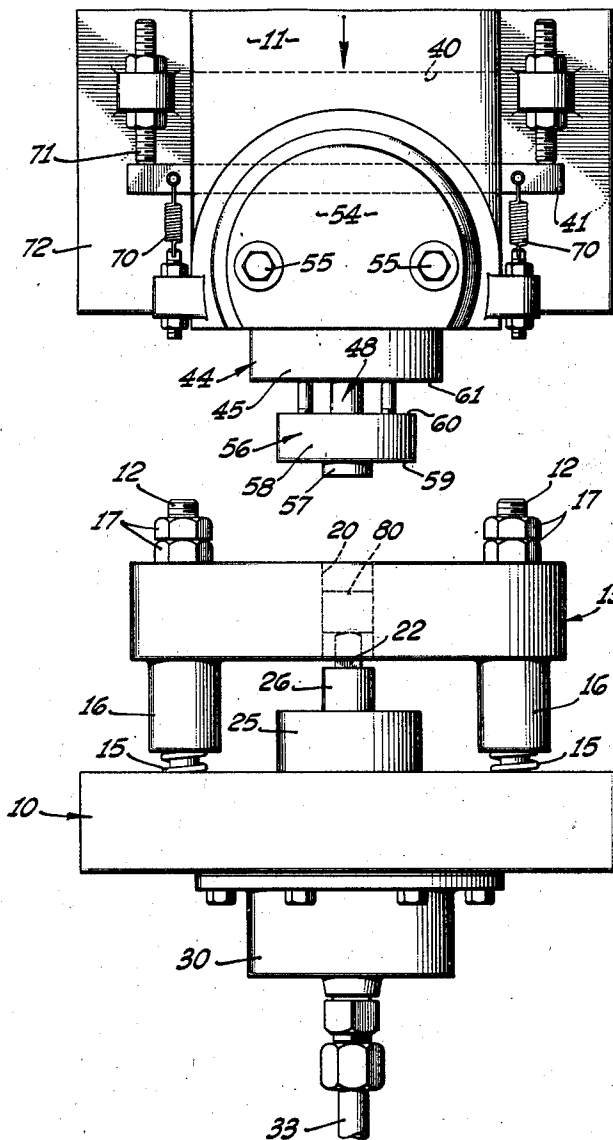


Fig. 1.

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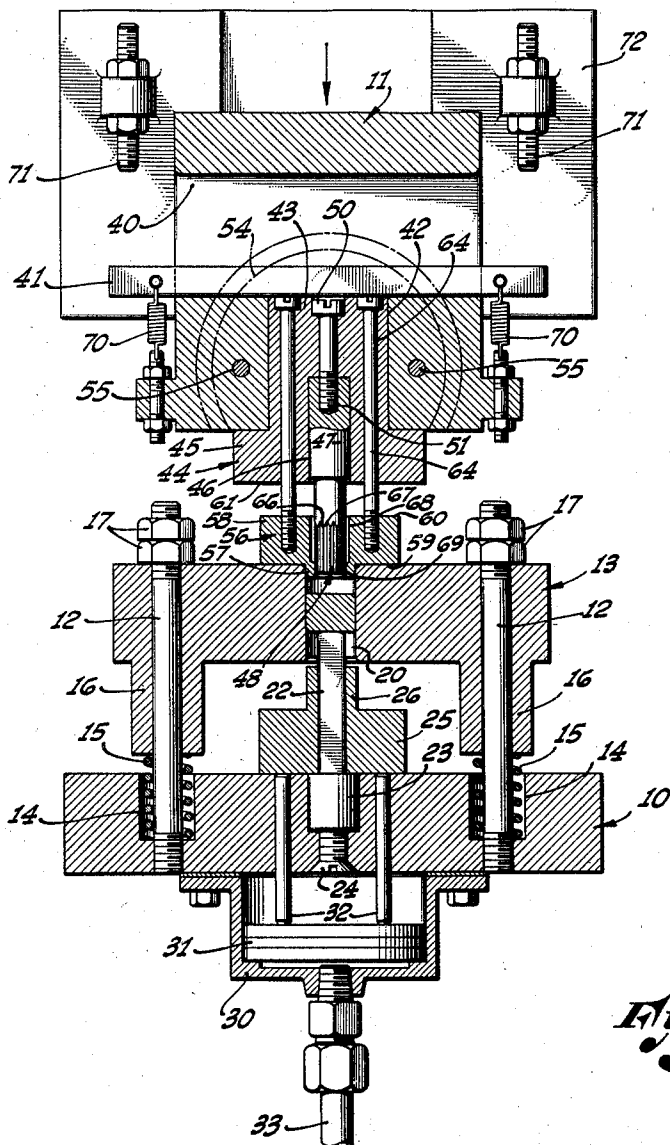


Fig. 2.

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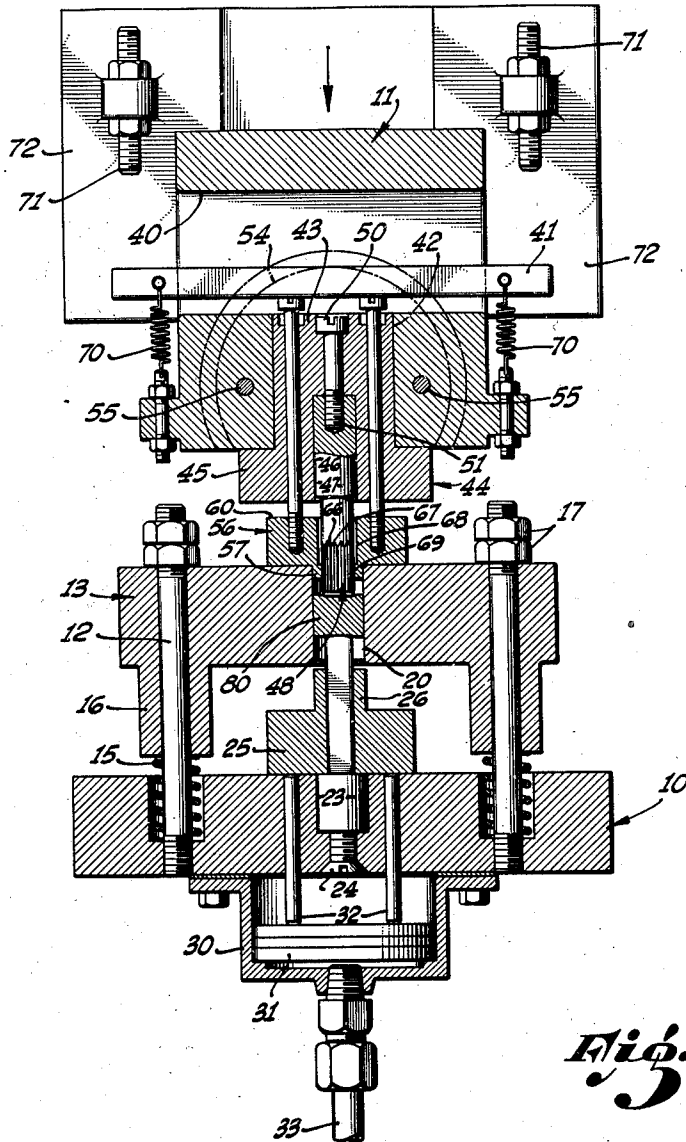


Fig. 3.

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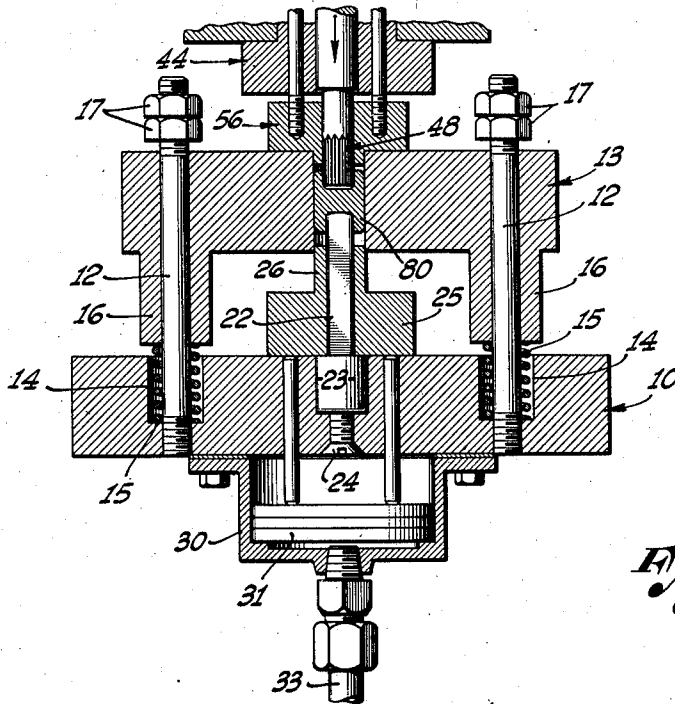


Fig. 4.

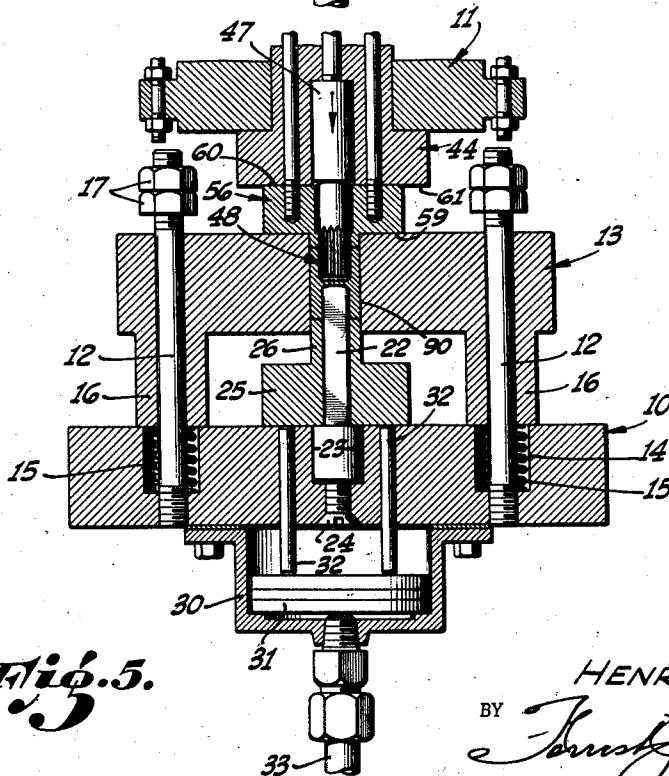


Fig. 5.

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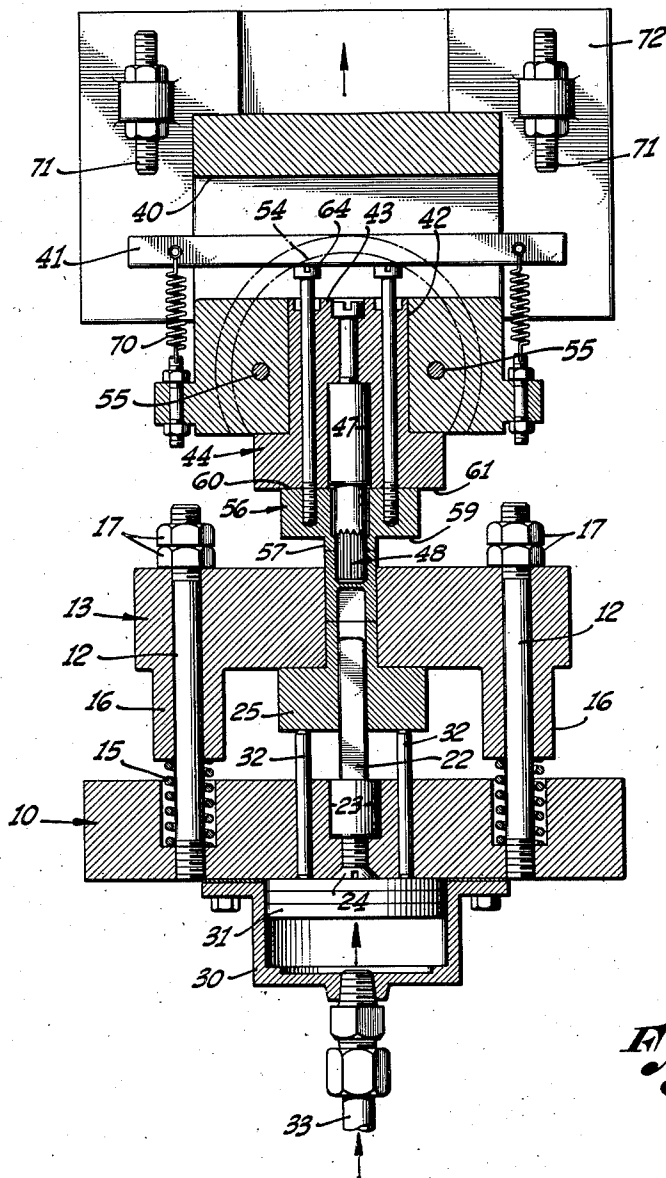


Fig. 6.

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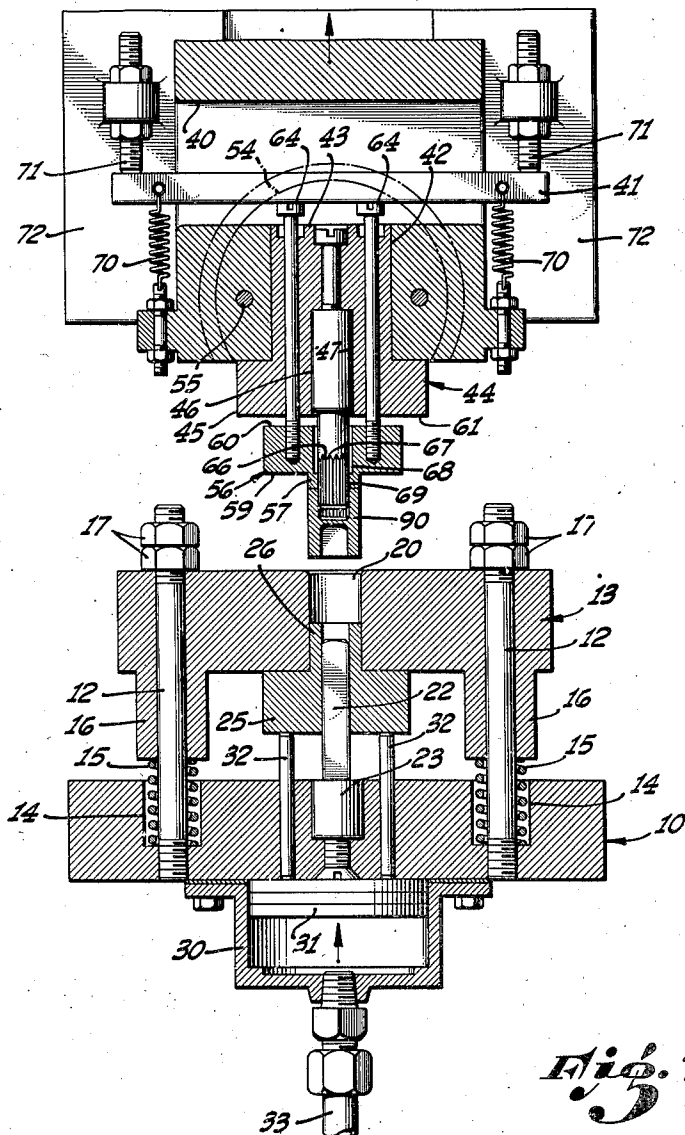


Fig. 7.

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UNITED STATES PATENT OFFICE

2,417,569

METHOD OF AND APPARATUS FOR PRESS
FORGING WRENCH SOCKETS AND THE
LIKE

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Application August 29, 1944, Serial No. 551,650

3 Claims. (Cl. 76-114)

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This invention relates generally to methods of and means for manufacturing wrench sockets, universal sockets and like articles, and deals more particularly with the production of such articles by press or die forging methods and apparatus.

Forging may be defined as the packing or kneading of a metal to close and weld voids in the original metal, and to compact and consolidate the crystalline structure, whereby the strength of the metal is greatly increased. The metal may be so packed or kneaded under repeated hammer blows, or by squeezing in a press under extreme hydraulic pressure. In press forging, there is a deep or "through" penetration of the metal by the extreme pressure exerted, and maximum refinement of the crystalline structure throughout the product results.

Despite the attractiveness of the press forging type of operation, however, wrench sockets and universal sockets are still, insofar as I am aware, invariably manufactured by the well known process consisting of boring and broaching solid bar stock. This conventional process is wasteful of material, slow and expensive. Proposals have in the past been made for manufacturing these wrenches by other methods, including the press or die forging type of process, but none of these to my knowledge, has been able to displace the well known standard but wasteful, slow and expensive process of boring and broaching.

The present invention may be regarded generally as dealing with improvements in the methods and apparatus disclosed in my prior application, Serial No. 537,064, filed May 24, 1944, entitled Method and means for making wrench sockets and the like.

According to the invention disclosed in said prior application, the product is press forged in an integral or unitary nonparting die cavity block, whereby die opening and closing operations are avoided, the die cavity surface does not suffer from the inherent weaknesses of parting planes, and fins along the sides of the press forged product are eliminated. In one of its forms the process employs a stationary die punch element positioned at the inner end of the die cavity, and a movable die punch insertable through the mouth of the die cavity and adapted to be forced into a heated billet of metal deposited therein and resting on said stationary punch. This procedure encounters difficulty in that the billet while under the extreme forging pressure slides somewhat along the wall surface of the die in the direction of the stationary punch element, which action abrades the die cavity and

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necessitates replacement with greater frequency than is desirable.

The general object of the present invention is the provision of improvements capable of obviating or substantially eliminating the described wear on the wall surfaces of the die cavity.

The manner in which this objective is accomplished in accordance with the present invention will best be left without further preliminary discussion to be gathered from the following detailed description of certain present illustrative apparatus capable of carrying the invention into effect, reference for this purpose being had to the accompanying drawings, wherein:

Fig. 1 is a fragmentary front elevational view of a hydraulic press incorporating the improvements of the present invention, showing the stationary bed of the press, and the lower portion of the vertically movable plunger head, the latter being shown at the top of its stroke just before descending;

Fig. 2 is a vertical medial section of the press shown in Fig. 1, but with the plunger head somewhat lowered in course of carrying the die punch toward the billet, which is shown in the die cavity;

Fig. 3 is a view similar to Fig. 2, but showing a subsequent operating position, in which the die punch has just engaged the billet and has caused the latter to expand slightly and to seize against the wall surface of the die cavity;

Fig. 4 is a view similar to a portion of Fig. 3, illustrating a subsequent operating position;

Fig. 5 is a view similar to Fig. 4, but showing the position at the completion of the product;

Fig. 6 is a view similar to Fig. 2, but showing a position wherein the product is in course of being removed from the apparatus; and

Fig. 7 is a view similar to Fig. 6, but showing the product being finally stripped from the punch.

As illustrative of the practice of the invention, I will describe one form of apparatus capable of carrying the invention into effect, and designed to produce a socket wrench of the type having a 12-point socket in one end, adapted to receive either a square or hexagonal bolt head or nut, and a squared socket in the other, adapted to receive a squared handle member or other suitable operating tool. It will of course be understood that various alternative forms of apparatus are possible within broad principles of the invention, and that various articles other than the specific type of socket wrench herein instanced may be produced in accordance with the invention. With the foregoing in mind, I

now proceed to a specific and detailed description of one illustrative practice of the invention.

In the drawings, the numerals 10 and 11 designate, respectively, the stationary horizontal bed and vertically movable plunger head of a hydraulic press, which may be generally of conventional design. Disposed above bed 10 and limitedly vertically movable with respect to bed 10 on long screws 12 carried by and extending upwardly from the latter is a floating, nonparting female die or die block 13. In the embodiment here illustrated, the screws 12 are threaded into bed 10, while counterbores 14 sunk into the upper face of the bed provide pockets for coil springs 15 which yieldingly and resiliently support the die 13 by engaging the lower ends of bosses 16 depending therefrom and encircling the screws 12. These bosses 16 are of a larger diameter than the counterbores 14 so as to be capable of seating on the upper face of bed 10. The normal spacing of the lower ends of the bosses 16 from the upper face of bed 10 is adjustable by means of nuts 17 on the upper ends of screws 12 which are set down against the upper side of die 13.

A vertical die cavity, preferably in the form of a bore 20, extends centrally through the medial portion of the die 13. This cavity or bore 20 preferably extends with straight substantially parallel lateral wall surfaces from the upper to the lower face of die 13, being here shown as of substantially equal diameters at its upper and lower ends, although use of a slight taper (not capable of being shown in the drawings) will facilitate extraction of the finished product from the die. Subsequent reference to the bore as "substantially cylindrical," or more broadly, to the die cavity as having substantially parallel sides, is not intended to exclude the use of such a taper. It is essential that the cavity or bore be of a nonundercut character, i. e., that its cross-sectional dimensions nowhere exceed the dimensions of its upper end or mouth, since otherwise extraction of the product through said mouth would be an impossibility, unless, of course, a parting die block be provided. The die member in which the bore 20 is formed is, of course, composed of suitably hardened steel, and the bore is preferably polished to a good smooth working finish.

Extending upwardly into the lower or leading end portion of bore 20 of the movable die 13 is a squared insert element or relatively stationary die punch 22 designed to form the lower socket in the product. However, while in the illustrative embodiment of the invention this member 22 is stationary, it is not necessarily so, and from the standpoint that it has relative longitudinal movement with respect to the billet into which it forms a socket, as well as to the floating female die, it may be regarded as a die punch. This insert element or punch 22 is here shown as carried by a cylindrical head 23 seated in bed 10 and secured therein by means of screw 24. The punch 22 may not be, of course, in all cases of squared cross-section, but in any given case will be complementary to the socket desired to be formed in one end portion of the product. Resting normally on the upper face of bed 10 and surrounding and freely slidable along punch 22 is a disc 25 formed with a tubular upwardly extending boss 26 adapted for reception inside bore 20. Normally, the upper end portion of said boss 26 is just below the lower end of bore 20, as appears in Figs. 1 and 2. The member 26 serves as a

ception therein when the die block 13 is forced downwardly against springs 15 in the operation of the apparatus, as shown for instance in Figs. 4 and 5.

The boss 26 also functions in a subsequent stage of the operation in stripping the press forged product from the bore 20. For this purpose, means are provided for elevating the disc 25 and its boss 26 above the position of Figs. 1 to 5. While such means may take various forms, I have here shown an air cylinder 30 secured to the underside of bed 10 and provided with a piston 31, which engages the lower ends of vertical pins 32 slidably mounted in bed 10 and engageable at their upper ends against the underside of disc 25. When air under pressure is admitted to the lower end of cylinder 30 via air supply conduit 33, piston 31 is elevated, and acts through pins 32 to elevate disc 25 and boss 26 to the stripping position shown in Fig. 6.

The vertical plunger head 11 is provided with the usual lateral cross-slot 40 for a knockout bar 41, and below slot 40 with a vertical bore 42 opening through its lower end. Received in this bore 42 is the reduced cylindrical shank 43 of a die punch holder 44, an enlarged head 45 at the lower end of said holder 44 being engageable with the underside of head 11. Extending upwardly into the holder 44 is a bore or socket 46 adapted to receive the shank 47 of a movable die punch generally designated by numeral 48. This die punch is secured to the member 44 by means of a screw 50 reaching downwardly from the upper end of the shank 43 and engaging screw threaded socket 51 in the end of the punch shank 47. As shown, the head of screw 50 is preferably countersunk into shank 43. Shank 43 is removably secured in position in the plunger head 11 by means of a removable insert block 54 secured to the plunger head as by means of screws 55, and designed to clampingly engage the shank 43. Such construction is more or less conventional and will be readily understood.

Also carried by plunger head 11 is a member 56 functioning first, as a closure for the upper end of the die cavity or bore 20, and second, as a stripper for removing the forged article from the die punch. This member 56 comprises, in the present embodiment of the invention, a lower annular part 57 which is receivable, with a close sliding fit, in the mouth or upper end portion of bore 20, and an enlarged upper disc-like part 58 whose horizontal lower face 59 is engageable with the top face of die 13 when the closure part 57 has been fully inserted within the bore 20, and whose horizontal upper face 60 is adapted to be engaged by the horizontal lower face 61 of the die punch holder 44 (Fig. 5). As here shown, the member 56 is carried by a pair of long screws 64 which reach downwardly through the die punch holder 44, and whose heads are countersunk into the upper end of the latter, the lower ends of said screws being screwed into disc 58. Screws 64 are of such length that member 56 is normally suspended in a position spaced somewhat below die punch holder 44, and the screws 64 are slidable in holder 44 to permit relative movement between holder 44 and member 56. The die punch 48 may have any desired cross-sectional shape, such as square, fluted, etc. It is, however, here shown as provided with a conventional type of alternating ridges 66 and grooves 67. Assuming the socket to be formed by die punch 48 is to be intended to fit either a square or hexagonal bolt head or nut, the die punch

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will preferably be given what is commonly termed as a "12-point" cross-section; that is, there will be twelve ridges 66 and twelve grooves 67. The disc-like part 58 of member 56 is provided with a bore 68 of sufficient diameter to pass the die punch with clearance, but the annular die closure element 57 is formed with an opening 69 complementary to the cross-section of die punch 48, and dimensioned to receive said punch with a close working fit.

Knockout bar 41 is normally held down to the lower end of slot 40 by means of coil springs 70 connected between its ends and the lower end portion of plunger head 11. In the course of upward movement of the plunger head, the two ends of the knockout bar engage a pair of stationarily mounted stop screws 71, carried by a stationary frame part 72 of the hydraulic press (Fig. 7), which limit the upward movement of the bar 41 and arrest the same while the plunger head is still rising. This knockout bar 41 is disposed over and engaged by the heads of the two screws 64 in the course of continued upward movement of the plunger head to perform a stripping function more fully described hereinafter.

Fig. 1 shows the press in the preliminary position, a billet of metal 89, preferably heated to a forging temperature, having been inserted in the die cavity or bore 20 and resting on the upper end of stationary punch 22, which is in its lowermost position, and the plunger head 11 being in its uppermost position. The plunger head 11 is then lowered, shortly reaching the position of Fig. 2, wherein the die closure element 57 has been inserted within the mouth of the bore 20 and the disc 58 has come into engagement with the upper face of the spring-supported floating die 13. With continued downward movement of plunger head 11, the die punch holder 44 will then slide downwardly on the screws 64, the heads of which, remaining stationary, arrest downward movement of knockout bar 41, so that the latter moves relatively upwardly in the slot 40 of the descending plunger head. The springs 70 are of course being stretched out at this time. The die punch 48 thus moving downwardly finally engages the billet 89, as appears in Fig. 3. Billet 89 is of an initial diameter such that it will be freely or loosely but relatively closely received within the bore 20, having preferably a slight clearance with the bore—for instance, it may be of a diameter of say $\frac{1}{64}$ " less than the diameter of the bore. This clearance being so small, no effort is made to show the same in Figs. 1 and 2 of the drawings. When the movable die punch 48 engages and begins to compress the billet between itself and the stationary die punch 22 (Fig. 3), the billet is expanded slightly under the extreme pressure exerted and engages tightly against the wall surface of the bore 20. A thin peripheral layer or shell of the billet is immediately chilled by contact with the wall surface of the bore 20, and at the same time seizes thereto. No relative movement between this initially formed shell and the bore 20 thereafter occurs until the forging operation has been completed.

Continued downward travel of the movable punch below the position of Fig. 3 causes the interior metal of the billet, still at a red forging temperature, to flow radially outwardly toward the chilled shell from approximately the mid-point of the billet, or the mid-way point between the two punches. This radially outwardly flowing metal of the billet exerts extreme pressure on the chilled shell, and if the point of pressure application

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shifts longitudinally of the shell to any material extent, the shell will shift longitudinally of the die bore. This undesired condition is avoided by providing for downward travel of the floating die in consonance with the downward travel of the point of maximum pressure application on the shell, as will be more fully explained presently.

The radially outwardly flowing metal upon reaching the chilled shell is turned both upwardly and downwardly thereby and flows or rolls along the inside of this shell and beyond its upper and lower ends to contact the surface of the bore 20, where it becomes chilled, and thus extends the shell. Fig. 4 shows an intermediate position, and shows how the metal has been built upwardly and downwardly along the bore from the position of the original billet. The shell is thus gradually extended, simultaneously upwardly and downwardly, until the lower end of the upper die closure element 57 and the upper end of the member 26 are reached, after which the metal merely fills in behind the shell to fully occupy the space provided (Fig. 5).

The continuing impingement of the radially flowing interior metal of the billet on its chilled shell as the punch 48 descends drags said shell (and also the floating die 13 within which the shell is seized) in a downward direction against the yielding spring support of the die, and the rate of this travel is substantially that of the rate of downward travel of the mid-point between the punches, or more exactly, of the rate of downward travel of the point within the billet from which maximum radial pressure is generated. Obviously, this rate of travel is substantially one-half the rate of downward travel of the punch 48. As stated, the point within the billet from which maximum radial pressure is generated is ordinarily the mid-point of the billet, or mid-way point between punches, though if the lower punch is of lesser cross-sectional area than the upper, the point in question will be shifted somewhat toward the upper punch and vice versa. It may here be noted that the upper die closure member 56 follows the die 13 in the downward movement of the latter.

It will thus be seen that the completed forged product 90, with its 12 point and squared sockets 91 and 92, respectively (Fig. 5), has been forged without relative sliding of the metal of the product against the surface of the die bore 20 at any stage of the process.

Broadly as to method, the desired result has been accomplished by maintaining the die positioned opposite the mid-point between the two relatively approaching punches. In another manner of expression, the relative movement between the stationary punch and the die is made to be substantially equal to the relative movement between the movable punch and the die. It will be obvious that this procedure may be carried out in various forms of apparatus, in which either one or both of the punches are movable. The specific form of apparatus herein described is of advantage, however, in that the floating die is enabled to respond or accommodate itself freely to any longitudinal thrust exerted on it through the billet, whereby all chance for longitudinal slippage between billet and die is eliminated.

The forged product is extracted from the press as now to be described. It will be understood that in the position of Fig. 5, the product 90 will be seized onto both the movable 12-point punch 48 and the stationary punch 22, as well as against the surface of the bore 20. A slight cooling and

consequent shrinkage occurs, however, and since the extreme forging pressure is relieved as the plunger head starts to ascend, no great difficulty is encountered in breaking the product free of the die. As or just before the plunger head 11 of the press is elevated from the position of Fig. 5, air under pressure, preferably under the automatic control of a valve (not shown) synchronized in any conventional manner with the plunger head, is admitted to cylinder 30, causing upward pressure to be exerted on piston 31, pins 32 and disc 25, and therefore, through the boss 26 projecting upwardly from the latter, on the underside of the forged product 90. This upward pressure aids in breaking the product free from the wall surface of the bore 20 and from the punch 22, and hence permits it to be elevated with the punch 42. Upward travel of disc 25 is limited by engagement with the underside of the floating die 13, which is returned to its initial position by its springs 15 (Fig. 6).

Fig. 7 shows a subsequent stage, the plunger head having been elevated nearly, but not quite, to its initial position, and the knockout bar 41 having come into engagement with the stop screws 71, and therefore, through its engagement with the screws 64, having arrested upward movement of the disc 56 carried by the latter. Continued upward travel of the plunger head following such arresting of the disc 56 results in stripping the forged product from the die punch 42 because of the engagement between the die closure element 57 formed on disc 56 and the upper end of the product. It will be understood that by the time the plunger head has been returned to the position of Fig. 1, the product 90 will have been stripped entirely from the punch.

I claim:

1. The method of press forging a socketed article, that includes loosely but closely confining a heated billet in a straight and substantially parallel sided die cavity formed in a female die, causing impingement upon opposite ends of said billet by two aligned piercing punches by effecting relative movement of said elements toward one another, whereby said billet is first slightly expanded into tight contact with the wall surface of said die cavity, and a thin shell of the billet is chilled by said contact and caused to seize to said wall surface, continuing relative movement of said piercing punches toward one another, and thereby causing hot metal from the interior of the billet to flow first radially outwardly to said shell, then to divide and move in opposite directions longitudinally along said shell and beyond the two ends thereof to gradually extend said shell, and at the same time permitting the female die to float bodily in a direction parallel to the line of movement of said punches in a manner to yield under longitudinal thrusts exerted thereon through said shell, whereby tendency for relative movement between said shell and the die is minimized.

2. The method of press forging a socketed article, that includes loosely but closely confining a heated billet in a straight and substantially parallel die cavity formed in a female die, positioning a piercing punch with its end received within said die cavity and in engagement with

one end of said billet, advancing another piercing punch into said die cavity in a manner to engage and the other end of said billet and subject said billet to compression between said two punches whereby it expands radially and contacts the wall surface of said die cavity, and whereby a thin shell of the billet is chilled by said contact and seizes against said surface, continuing the advancing movement of the second mentioned punch to a predetermined separation distance from the first mentioned punch and at the same time permitting bodily movement of the female die in the same direction under thrust exerted thereon through said chilled shell from the compressed interior metal of the billet, whereby tendency for relative movement between the chilled shell of the billet and the female die during penetration by the punches into the two end portions of the billet is relieved.

3. The method of press forging a socketed article, that includes loosely but closely confining a heated billet in a straight and substantially parallel sided die cavity formed in a female die, said billet being of a cross-section complementary to the die cavity and sized to fit with a slight all-around clearance therein, causing impingement upon opposite ends of said billet by two aligned piercing punches by effecting relative movement of said elements toward one another, whereby said billet is first slightly expanded into tight contact with the wall surface of said die cavity, and a thin shell of the billet is chilled by said contact and caused to seize to said wall surface, continuing relative movement of said piercing punches toward one another, and thereby causing hot metal from the interior of the billet to flow first radially outwardly to said shell, then to divide and move in opposite directions longitudinally along said shell and beyond the two ends thereof to gradually extend said shell, and at the same time permitting the female die to float bodily in a direction parallel to the line of movement of said punches in a manner to yield under longitudinal thrusts exerted thereon through said shell, whereby tendency for relative movement between said shell and the die is minimized.

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