A power drop forging press for forming relatively large bolts or similar objects employed in combination with a device for horizontal alignment of the lower die blocks, a device for securing vertical alignment of the stock and a device for ejecting the formed bolt from the die blocks. The vertical securing device functions only during a portion of the first stage of the power stroke while the ejecting device serves both to remove the formed bolt from the die blocks and also to define the length of the die cavity. The press employs a unique two-stage power stroke to hot form the head of the bolt and cold form the shank of the bolt, thus providing close tolerances on the shank end of the bolt while forming the head such that no stress risers exist at the juncture of the shank and the head.

4 Claims, 8 Drawing Figures
MACHINE PRESS FOR FORGING BOLTS AND THE LIKE

BACKGROUND OF THE INVENTION

1. Field of the Invention
The invention relates to a power drop forging press and the method for forming relatively large bolts or similar objects.

2. Prior Art
Drop forging is a technique well known in the art. The usual practice is to heat a stock ingot in a heating device, place the stock in lower die blocks and then drop the upper die block onto the lower die block. This method of forging in addition to fabricating the desired object improves the quality of the metal. The course crystals of the metal, resulting from solidification in stock ingot mold are kneaded and refined. Blow holes and layers of slag are consolidated and are usually welded together in the forging process. This results in a more ductile and stronger product than cast metal and has a much greater resistance to shock and fatigue stresses. Drop forging using power presses has been utilized form many different objects. However, no known prior art device mechanically forms a bolt head and reduces the diameter of the shank in one operation, particularly where precise tolerances in dimensions are required on both ends of a bolt.

In the manufacturer of prior art bolts, of the type disclosed herein, the head of the bolts have been formed utilizing power drop presses. After hot forging the head, the shank end of the stock is machined to its proper finished dimension, or the shank end may be formed in a separate power drop press. These techniques require a dual step operation for forming a single bolt while the present invention forms the same bolt in a one-step operation. In addition, the present invention utilizes a two-stage power stroke which causes a unique stress flow pattern to result in the finished bolt. In this technique, the head of the bolt is formed after one end of the stock has been heated, while the shank end, is formed at the same time by cold drop forging. Thus, the present invention utilizes the more preferred method for forging both the shank and bolt head in one operation. The bolt is produced in a twostage power stroke procedure, in which no stress risers exist at the juncture of the shank and the head. In addition, several improvements have been developed for use in connection with a standard drop press. These new features include a vertical positioning device which positions and secures the stock ingot in vertical alignment with the upper and lower die blocks until contact is made by the upper and lower die blocks with the stock. Another feature of the present invention comprises a horizontal positioning device which permits a stock ingot to be disposed within the lower die blocks and then moved into alignment with the upper die blocks in preparation for the power stroke.

SUMMARY OF THE INVENTION
A press used in a power drop forging procedure forming relatively large bolts, is disclosed. A typical press is utilized in combination with a device for horizontally positioning the lower die blocks into alignment with the upper die blocks, a vertical positioning device which mechanically secures the stock in position in the lower die blocks and an ejecting device for forcing the formed bolt out of the lower die blocks. The power drop press employs a unique process for forming a stress effective bolt which has a shank of precise dimensional tolerances. The method for forming the bolt comprises the steps of: heating one end of the stock, disposing the stock in the lower die blocks, vertically positioning the lower die blocks, vertical securing of the stock in alignment with the die blocks and withdrawing of the vertical positioning device as the power drop press proceeds through a two-stage power stroke.

It is therefore an object of this invention to provide a bolt which is able to transmit stress between the shank and head without causing any significant stress build up between the head and shank.

It is another object of the present invention to provide a press used in a drop press which employs a two-stage power stroke for forming a bolt.

Still another object is to provide a horizontal positioning device, which aligns the lower die block with the upper die blocks, and a vertical positioning device which secures the stock in the die blocks during part of the power stroke.

BRIEF DESCRIPTION OF THE DRAWINGS
FIG. 1 is an elevation view of the power drop press and heating furnace;
FIG. 2 is a blown-up view of FIG. 1 illustrating the upper and lower die blocks and horizontal positioning device;
FIG. 3 is a section view taken along line 3—3 of FIG. 2 illustrating the lower die blocks and the horizontal and vertical positioning devices;
FIG. 4 is a sectional view taken along line 3—3 of FIG. 2, however the lower die blocks and vertical positioning device has been moved into alignment position with the upper die blocks;
FIG. 5 is a sectional view taken along line 6—6 of FIG. 4 illustrating the die blocks and vertical positioning device;
FIG. 6 is a sectional view taken along 6—6 of FIG. 4; however the power drop press is shown in the first stage of the power stroke;
FIG. 7 is a sectional view illustrating the press in the final stage of its power stroke; and, FIG. 8 is an illustration of the formed bolt and the pattern of stress flow lines.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT
The present invention employs a press, as shown in FIG. 1, of the type well known in the art which is generally comprised of: a head press 38, an upper and lower frame 39 and 91, upper and lower die blocks 30 and 40, and a stationary platen 90. The present invention employs a standard press in combination with several new features and a unique method for forging relatively large bolts from cold rolled or ground stock material. The additional improvements are comprised of positionable lower die blocks 40, a ram ejector 50, a horizontal positioning device 50 and a heat sink 81.

The present invention involves a new method for forging large bolts or similar objects in a power drop press. The presently preferred embodiment utilizes a 150 ton press or 300 ton press to form bolts up to 3 inches in diameter. Other size presses may be employed to form larger or smaller bolts within the scope of the invention. The bolt 20 shown best in FIG. 8, has a shank with a first portion 21 and a lower second por-
tion 22. The first portion 21 is larger in diameter than the lower portion 22. A bevel 24 disposed on approximately a 15° incline from the lower portion 22 forms a smooth transition from the the second portion 22. The lower portion 22 of the shank is forged to a precise diameter which allows standard threads to later be rolled or die cut thereon. Tolerances of plus or minus 0.0001 inches are desirable for the rolling of threads. These tolerances and better tolerances are obtainable in the present invention. The head of the bolt 23 has a hex head cavity 29 formed therein for providing a coupling which can be used to tighten or loosen the bolt. A small precisely formed fillet 27 joins the head 23 to the upper portion of the shank 21 and rounds 28 are formed on the top and bottom edges of the head 23. The bolt 20 is formed in one step operation from standard stock material 19, the stock is best illustrated in FIG. 5. The stock may be steel aluminum, titanium and other metals. The formed bolt 20 has several unique features which result from the forging method and will be more fully described hereinafter, however the bolt is dimensionally formed to very close tolerances which is extremely desirable in many industrial applications.

The present invention will now be described in regards to the basic components of the presently preferred embodiment. The upper die blocks 30 are best shown in FIGS. 2 and 7. The die blocks in the presently preferred embodiment are made from carefully manufactured alloy steels. The die blocks must have the ability to withstand severe strains imposed by high pressures on hard metals. This alloy steel should provide long life with a minimum of impression wear on the surface of the die blocks. The upper die blocks 30 are coupled to the lower surface 37 of the power head 38 which is disposed on the upper frame 39. An adjusting ring 35 is mounted between the power hammer 38 and the upper die blocks 30 such that the length of the power stroke of the power hammer may be regulated. A plurality of adjusting springs 34 are disposed around the adjusting ring 35 and permit adjusting the length of the power stroke. The upper die blocks 30 have a lower surface 31 which is engageable with the lower die blocks 40. A cavity 32 is axially disposed in the upper die blocks on surface 31. This cavity 32 is for forming the head 23 of the bolt 20. A hexagonal projection 33 is disposed within cavity 32 and forms the hexagonal cavity 29 in the bolt 20.

The lower die blocks 40 are generally cylindrical in shape and are best shown in cross section in FIG. 7 and in plan view in FIG. 3. The lower die blocks may be formed from an alloy steel as employed in the upper die blocks. The lower die blocks 40 has an axial bore 41 therethrough for forming the shank of the bolt. Rounds 42 form a smooth transition between bore 41 and surface 44. Surface 44 engages the surface 31 of the upper die blocks 30 during forging. The bore 41 has two coaxial portions 57 and 58. The upper portion 57 is larger in diameter than the lower portion 58 and a bevel 43 (FIG. 5) forms the transition between lower portion 58 and the upper portion 57. The longitudinal displacement of the bevel 43 from surface 44 will determine the length of stock which will later be available for threading. This lower portion 58 is formed to a precise diameter which permits standard threads to be placed on the stock after this end of the stock has been cold forged. The lower die blocks 40 are mounted on a square base 59 which has opposing sides 46, 47, 48 and 49, and is slidably mounted on the platen 90. Sides 48 and 49 are engageable with tracks 45 which are secured to the platen 90. The engagement of tracks 45 and base 59 permit base 59 and the lower die blocks 40 to be moved back and forth between a first and second position in a fixed path across the platen 90, as illustrated in FIGS. 3 and 4.

The ram ejecting device 50 is disposed partially within bore 41 and partially below bore 41 and is best illustrated in FIG. 7. The ram ejecting device 50 serves two basic purposes; first to define the lower end 52 of bore 41, and second to eject the formed bolt from the bore 41. This ejecting device is comprised of; rod 51, rod 54, pin 95, collar 94, and the ram ejecting cylinder 56. End 52 of rod 50 is positioned in bore 41 so as to form end 26 of the shank of bolt 20. Thus, the lower die blocks may be easily altered to manufacture bolts of different lengths. If a longer shank is required, rod 52 is shortened and if a smaller shank is required, rod 52 can be lengthened. Rod 51 bears on the upper end of rod 54 and engagement of rod 54 and pin 95 occurs in the C-shaped collar 94. Thus, when the lower die blocks are moved from their first position, the pin 95 is capable of disengaging rod 54. Rod 54 has one end with an increased diameter that fits in collar 94 and prevents rod 54 from falling through collar 94 when pin 95 is withdrawn from the collar. When the lower die blocks are returned to their initial position, pin 95 again engages rod 54 in collar 94. Pin 95 is coupled to cylinder 56 and is capable of being driven forcefully upward against rod 54. The cylinder 56 in the presently preferred embodiment is a pneumatic cylinder driven by solenoid switches and activated by control board 86, however either mechanical or other types of devices for supplying thrust may be employed.

The horizontal positioning device 60 is mounted on the upper surface of the platen 90 and is engageable with the lower die blocks 40 and member 59 and is best illustrated in FIGS. 3 and 4. This positioning device, in the presently preferred embodiment, is comprised of a pneumatic cylinder 61 for providing a force which is transmitted through rod 62 to member 59 and the lower die blocks 40. In an alternate embodiment, a mechanical or other type of device may be employed to provide the driving force. Rod 62 is coupled to member 59 by couplings 63. The positioning device also utilizes three mechanical stops for positioning the lower die blocks 40 into position. The first stop 65 is disposed such that it will engage side 46 of member 59 as the die blocks are positioned in their first position, FIG. 3, for receiving the stock 19. The cushioning device 64 is a hydraulically operated cylinder and serves to slow the die blocks and member 59 as they approach stop 65. The second stop 67 and third stop 68, are disposed so as to engage side 47 of member 59 when member 59 and the lower die blocks are moved to their second position, FIG. 4, in alignment with the upper die blocks 30. Cushioning device 66 serves a similar function as cushioning device 64 and is mounted near stop 67. This arrangement of mechanical stops in combination with tracks 45 and driving cylinder 61 permit the lower die blocks and member 59 to be positioned into two different positions, one for inserting stock 19 and one for aligning the upper and lower die blocks so that forging can be accomplished.

The vertical securing device, 70, is best shown in FIGS. 3, 4, 5 and 6. With reference to FIG. 5, the de-
vice is shown, which is comprised of a vertical arm 71, a horizontal arm 72, a gear cluster comprised of a major gear 73 and a minor gear 74, and a housing 75. The purpose of the device is to align and secure stock 19 into position until the last possible instant, at which time the horizontal securing arm 72 is removed since the stock is held in alignment by engagement of the stock with both the upper and lower die blocks (FIG. 6). The horizontal arm 72 of the positioning device is positioned such that its lower surface engages the upper surface 34 of the lower die blocks 40 when it is fully extended as shown in FIG. 5. End 78 of arm 72 has formed therein a trough 79 with a circular end the diameter of which is slightly larger than the diameter of the stock 19 (FIG. 4). Thus, in its fully extended position (FIG. 4) end 78 of arm 72 is positioned so as to contact the rod above the die blocks. This contact along with the lower die blocks secures proper vertical alignment of the stock. Vertical arm 71 of the vertical securing device has end 69 which is engageable with surface 37 of the power head 38. When the power head 38 is displaced vertically it causes arm 71 is displaced an equal distance which rotates the gear cluster and withdraws arm 72. Both vertical arm 71 and horizontal arm 72 have gear tracks 76 and 77 disposed thereon. These gear tracks are engageable with a gear cluster containing a major gear 73 and a minor gear 74. Tracks 76 of arm 71 are engageable with gear 74 while tracks 77 are engageable with gear 73. The ratio between the minor and major gears is fixed such that a vertical displacement of the vertical arm during the power stroke moves the vertical arm a sufficient distance to be withdrawn from between the upper and lower die blocks.

The platen 90 of the press has a slotted aperture 92 disposed therethrough. This aperture 92 is centrally located on the platen between tracks 45 such that the lower die blocks 40 may move from a first position, FIG. 3, to a second position, FIG. 4. The platen 90 is coupled to the lower frame 91, FIG. 1. The lower frame 91 in turn supports the entire power drop press. Control switches 86 are mounted to the lower frame 91 and control the operation of the press. FIG. 1, is used to heat end 16 of the stock 19, prior to the stock being placed in the lower die block. The heating furnace is of the type well known in the art, however, it has a heating pit 81 which is comprised of coils 82 which are situated such that only end 16 of the stock is heated. Care must be exercised in the heating of stock. Metals that are heated too long at too high a temperature, oxidize rapidly, and form an excess amount of scales which not only wastes metal but also prevents the production of smooth surfaces on the forged object. Thus, the heating coils are carefully controlled to heat the stock for only a specific time at a specific temperature. The time and temperature vary depending on the metal being forged.

Having now described the components of the presently preferred embodiment, the method for forming a relatively large bolt in a single operation will be described. Initially, a cylindrical piece of stock material 19, having a specific predetermined size and volume, depending on the size of bolt to be formed, is machined such that end 16 is beveled (FIG. 8). This beveled end 16 enables threads to later be precisely formed on the shank of the formed bolt 20. End 17 of the stock 19 is then inserted into the heating pit 81 for a specified amount of time which permits end 17 to be properly heated. The stock 19 is then manually removed from the heating pit 81 by an operator using tongs and placed into the lower die blocks 40 following the path defined by the phantom lines in FIG. 1. It should be noted that the presently preferred embodiment employs a manual technique for transporting the heated stock to the lower die blocks, a mechanical apparatus may perform that function.

The lower die blocks are initially positioned as is shown in FIGS. 1 and 3. This permits insertion of the stock 19 into the lower die blocks as illustrated in FIG. 1. Note that if the lower die blocks are in the second position the stock cannot be inserted into the lower die blocks because of the small distance between the upper and lower die blocks. The unheated end 16 of stock 19 is disposed in the lower die blocks while the heated end 17 protrudes from the lower die blocks as shown in FIG. 5. The lower die blocks 40 are then moved into alignment with the upper die blocks 30 (FIGS. 4 and 5) by activating the horizontal positioning device 60. Cylinder 61, of the horizontal positioning device 60, drives rod 62 forcing the lower die blocks 40 and member 59 into alignment with the upper die blocks 30 as is shown in FIG. 4. At this point, the vertical positioning device 78 is disposed in place, such that end 78 and slot 79 of the horizontal arm 72 engages the stock 19, while end 69 of the vertical arm 71 engages surface 37 of the power press 38.

At this point, the power press 38 commences its vertical power stroke. The first stage of the power stroke consists of only a small vertical displacement and only partially forms the bolt, as is shown in FIG. 6. Immediately following the first stage of the power stroke, the second stage commences driving the upper die blocks against the lower die blocks completing the forging operation.

The presently preferred method of forming a bolt provides a very efficient structural bolt with very precise dimensions on the surface which is threaded. This unique two-stage power stroke cause the stress flow lines 94 to be formed in the bolt similar to those shown by the phantom lines in FIG. 8. These stress flow lines 94 flow outward from the shank of the bolt to the outside of the head and do not create high stress concentration at the juncture between the head and the shank.

During the first stage of the power stroke of the power head 38 the vertical arm of the vertical positioning device 70 causes the gear cluster to commence rotation and withdrawal of the horizontal arm 71 from between the upper and lower die blocks. However, end 78 engages and secures the vertical alignment of the stock 19 until contact is made between the stock and both upper and lower die blocks.

After the second stage of the power stroke is completed, the upper and lower die blocks are positioned as shown in FIG. 7. The power press is again activated and the head is withdrawn to the position shown in FIG. 1. The horizontal positioning device 60 is then activated and member 59 and lower die blocks 40 are moved back into its initial position. Removal of the formed bolt 20 is accomplished by activating a switch on control panel 86, which in turn powers cylinder 56 and drives pin 95 against rod 54 and 51. The vertical displacement of rod 51 causes the formed bolt 20 to be forcibly ejected from bore 41 and the lower die
blocks. At this point, the press is again ready to receive a new stock 19 and again forge a new bolt.

1 claim:

1. In a forging press having a stationary platen and a first and second set of die blocks, said press for forging from stock a formed object having a first and second end in which said first end is hot forged and said second end is cold forged, the improvements comprising:
   a. a positioning means for moving said first die block into a first and second position on said platen, in said first position said stock being disposed in said first die block and in said second position said first die block being aligned with said second die block;
   b. aligning means for aligning said first and second die block in a first and second position, said means comprised of a plurality of stops disposed on said platen;
   c. securing means for holding said stock in alignment with said first and second die block until said first and second die block contact said stock;
   d. driving means for driving said press such that said forging is accomplished by a power stroke;
   e. withdrawing means for withdrawing said securing means from contact with said stock during said power stroke;
   f. ejecting means for ejecting said formed object from said first and second die block; and
   g. heating means for heating one end of said stock prior to said stock being disposed in said first die block.

2. The forging press of claim 1, wherein said positioning means is comprised of a pneumatic cylinder which forcefully drives said first die block across said platen, until said first die block contacts at least one of said aligning means.

3. The forging press of claim 1, wherein said securing means is disposed on said withdrawing means, said withdrawing means having a first arm, said first arm containing a first gear track, said first gear track capable of engaging a gear cluster, said gear cluster capable of engaging a second gear track disposed on a second arm, said second arm having one end positioned adjacent said press such that any displacement of said press causes said second arm to displace, rotate said gear cluster and displace said first arm.

4. The forging press of claim 1, wherein said ejecting means is comprised of a pneumatic cylinder capable of driving a rod through said first die block for removing said formed object therefrom.

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