Oct. 17, 1950 P. LIDDICOAT 2,526,489

METHOD AND APPARATUS FOR MAKING DRILL BITS

Filed Dec. 4, 1947 2 Sheets-Sheet 1

FIG. 1.

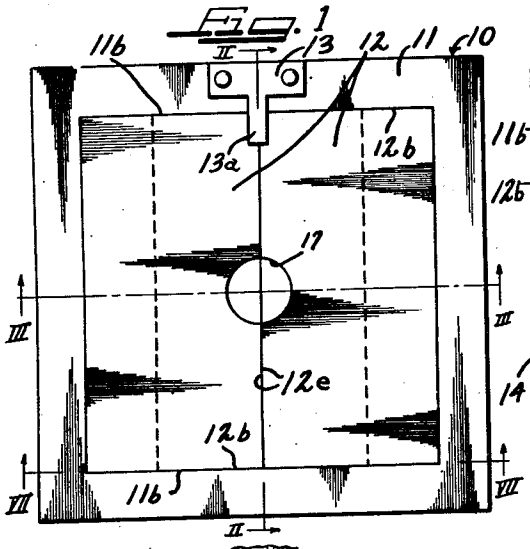

FIG. 2.

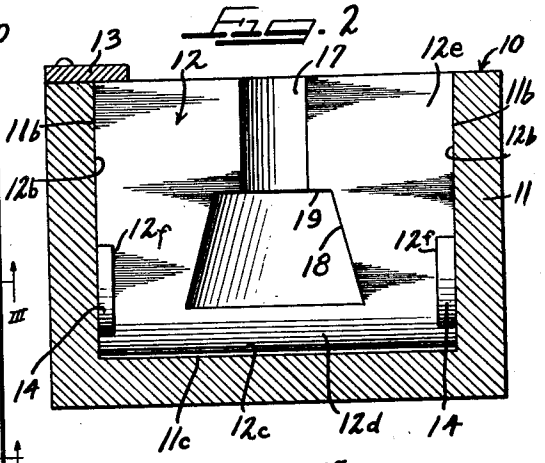

FIG. 3.

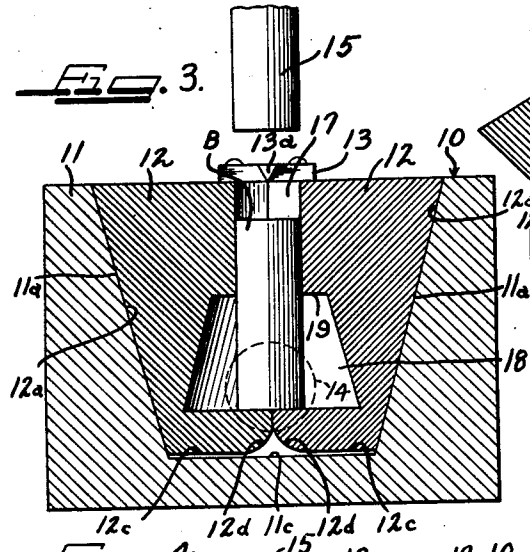

FIG. 4.

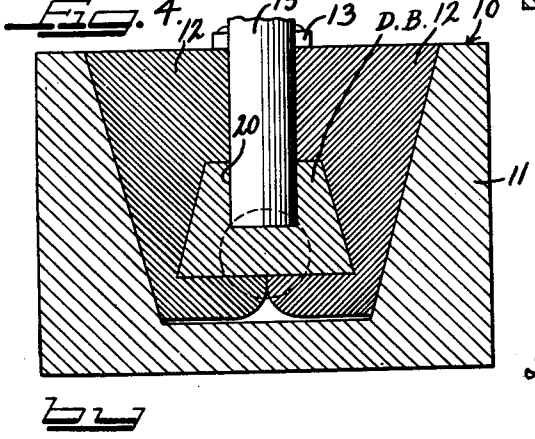

FIG. 5.

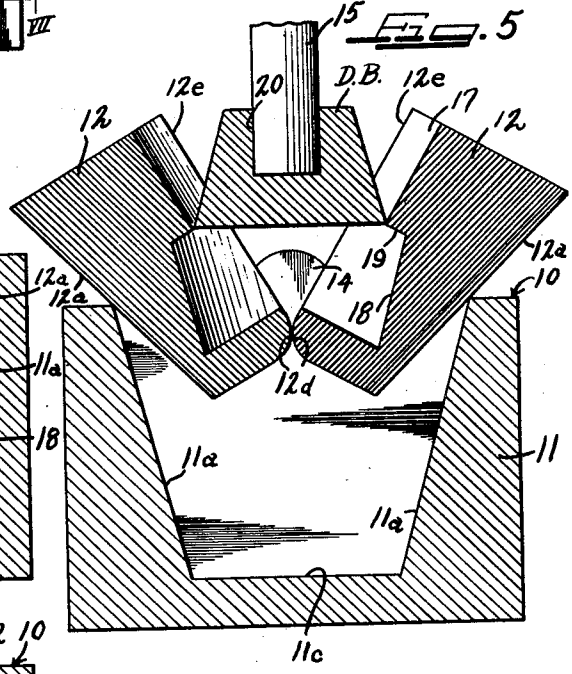

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FIG. 6.

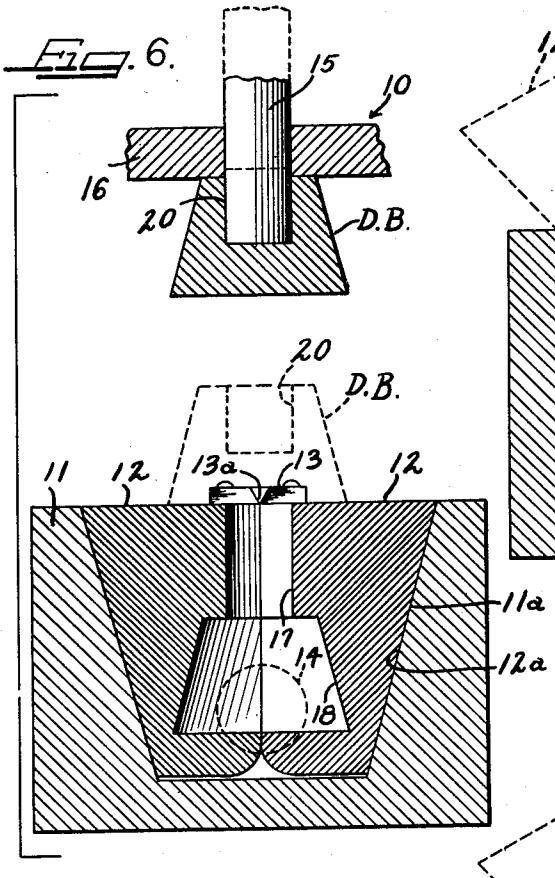

FIG. 7.

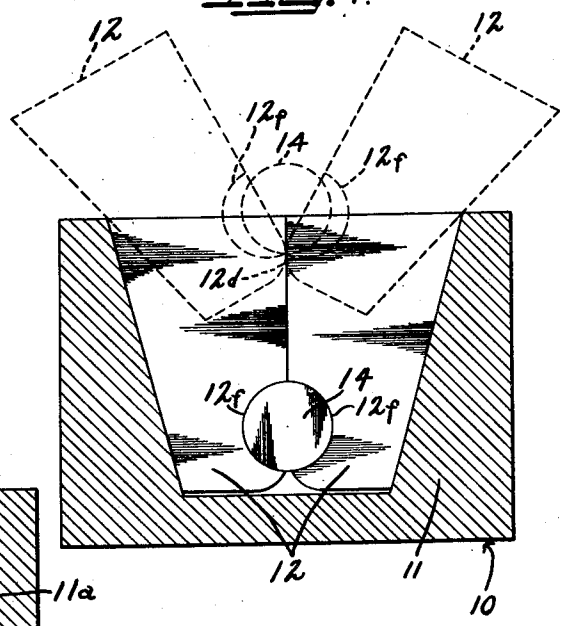

FIG. 9.

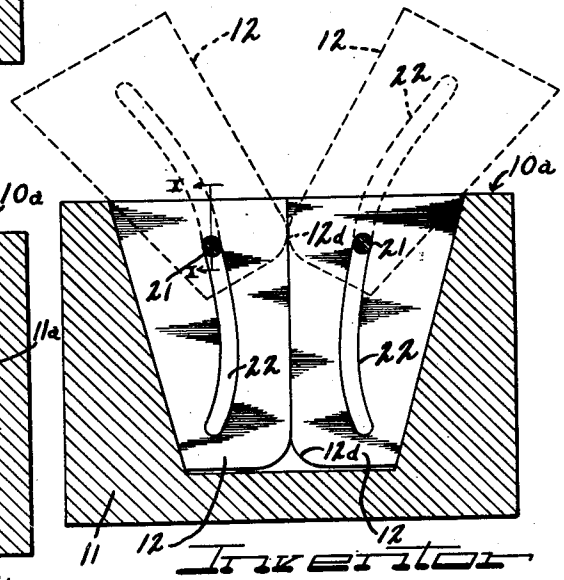

FIG. 8.

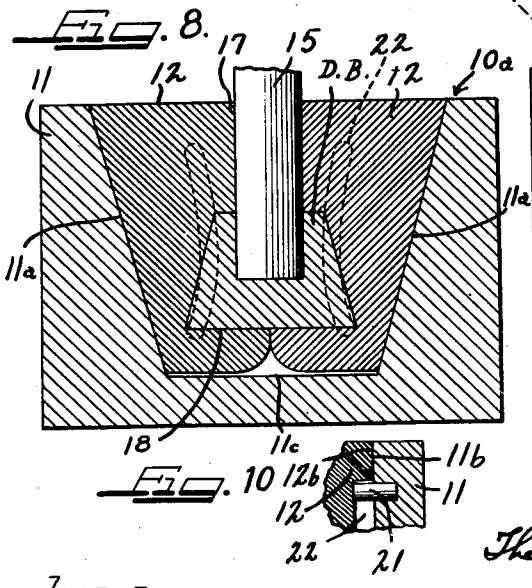

FIG. 10

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Patented Oct. 17, 1950 2,526,489

UNITED STATES PATENT OFFICE

2,526,489

METHOD AND APPARATUS FOR MAKING DRILL BITS

Percill Liddicoat, Niagara on the Lake, Ontario, Canada

Application December 4, 1947, Serial No. 789,633

13 Claims. (Cl. 76—108)

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This invention relates to the manufacture of articles such as drill bits and the like and includes an automatically-operating wedge die for shaping the articles.

Specifically this invention deals with the die-forging of drill bits or the like in a split die so arranged relative to a die holder that the die segments are wedged together during the forging step, automatically separate as the forged article is retracted, and then automatically return to closed position to form a support for the retracted article.

While the invention will hereinafter be specifically described in connection with the manufacture of drill bits, it should be understood that the invention includes the die-forging of other shapes and especially shapes which necessitate separation of die segments to permit their release from the die cavity.

In accordance with this invention a pair of opposed dies, having flat mating faces at the parting line therebetween, are provided with tapered end walls for wedging engagement in a die block to hold the mating faces in wedged-together relationship for maintaining a true die cavity. The die block is sufficiently strong and rigid so that it will not deform even when subjected to tremendous expanding pressures such as might occur during a forging operation tending to separate the dies. The dies have the forming cavity therein communicating with the top walls of the dies through a reduced punch-receiving passage.

A punch of a die press is reciprocally mounted through a stripper bar and has an active lower end fitting into the punch passage to act on a billet in the die cavity for forging the billet into the shape of the cavity. The punch also pierces and enters into the metal of the billet to form a recess therein and to become firmly connected with the finished article. Retraction of the punch causes the article to raise with the punch. Since the die cavity is wider than the punch passage, and since the article fills the die cavity, the article cannot be removed from the cavity unless the dies are opened up.

The retracting movement of the punch and article tends to raise the dies from the die block, and, since the dies are top-heavy, they tend to ride on their tapered end walls until they are

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lifted out of the die block a sufficient distance so that they can tilt on these end walls to an open position. The die block can be equipped with means to aid or initiate this tilting of the dies. The tilted dies open up a path sufficiently large for removal of the article from the die cavity. Upon removal of the article, the dies fall by gravity back into the die block which guides them to again place their mating faces in mated engagement for the next die-pressing operation.

As the punch is retracted through the stripper bar, the article impaled on the punch is stripped from the end of the punch and falls by gravity on top of the closed dies. Since the article is wider than the punch passageway or die hole in the top of the dies, the stripped article will rest on top of the dies where it can be easily removed.

In one embodiment of the invention the dies have mating semi-circular recesses in their side walls receiving a circular disk. These disks function as turning axes or pivots for the dies and prevent misalignment of the dies in the block.

In another embodiment of the invention the dies have cam grooves in their side walls receiving pins carried by the die block to guide the dies between closed abutted-together position and open tilted-apart position.

It is, then, an object of this invention to provide a method and apparatus for forming shaped articles in a die cavity in such a manner that the die cavity will always be maintained in proper closed condition during the forming operation and will automatically open up to permit discharge of the shaped article.

A further object of the invention is to provide a split die arrangement for die-forging operations wherein separate die segments are wedged together during a die-pressing operation and are automatically separated to open up the die cavity whenever an article shaped therein is retracted out of the dies.

A further object of the invention is to provide a die-forging apparatus especially suitable for making drill bits or the like wherein complementary die segments are wedged into closed position during the forging operation and are automatically separated to open up the die cavity

whenever the forged article is retracted from the die cavity.

A still further object of the invention is to provide a method of making shaped articles such as drill bits or the like by pressing a plunger against a metal billet in a die cavity for simultaneously shaping the billet to the contour of the cavity and impaling the shaped article on the plunger.

A still further object of the invention is to provide a method of making shaped articles with hollow shanks by simultaneously impaling the article on a punch to form the hollow shank and deforming the body of the article to the desired shape in a die cavity.

Another object of the invention is to provide a method of making recessed shaped articles wherein a plunger acting on a billet in the die cavity of a split die simultaneously pierces the billet to form the recess and presses the billet into conformity with the die cavity to impale the shaped articles thereon whereupon retraction of the plunger will carry the article therewith and separate the split dies to open up a discharge path for the article.

A still further object of the invention is to provide a method of making shaped articles in a die-forging press wherein the article is shaped in the die cavity of a split die by a plunger which pierces the article and retracts the shaped article from the split die to carry it above the die and wherein further retractive movement of the plunger results in stripping of the article therefrom to fall by gravity on top of the closed die.

Another object of the invention is to provide die-forging apparatus including die segments held by a die block in wedged-together relationship during the die-pressing operation, and arranged to automatically separate upon retraction of the shaped article therefrom.

Another object of the invention is to provide die-forging apparatus wherein split dies coact to define an entrance hole and an enlarged die cavity and wherein a die punch impales an article being forged in the die cavity for retraction through the entrance hole as the dies automatically tilt to open up the entrance hole.

A still further object of the invention is to provide a split die-forging apparatus including means for automatically maintaining the dies in alignment and guide means for directing the dies between closed and opened positions.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred examples only, illustrate two embodiments of the invention.

On the drawings:

Figure 1 is a top plan view of one form of die-forging apparatus according to this invention.

Figure 2 is a vertical cross-sectional view, with parts in end elevation, taken along the line II—II of Figure 1.

Figure 3 is a vertical cross section, with parts in side elevation, taken along the line III—III of Figure 1 and also showing the die-forging punch and a billet or work piece in the dies.

Figure 4 is a view similar to Figure 3 but showing the position of the punch at the end of the forging stroke and illustrating the manner in which the billet or work piece is pierced and shaped.

Figure 5 is a view similar to Figure 4 but illustrating the positions of the parts when the punch is retracted to remove the shaped article from the die cavity.

Figure 6 is a view similar to Figure 4 but illustrating the positions of the parts as the finished article is stripped from the punch, and showing, in dotted lines, how the finished article rests on top of the dies after the stripping operation.

Figure 7 is a vertical cross-sectional view, with parts in side elevation, taken along the line VII—VII of Figure 1 and showing, in dotted lines, the manner in which the disk serves to maintain the dies in alignment.

Figure 8 is a vertical cross-sectional view, with parts in side elevation, showing a plunger and shaped articles in another arrangement of dies according to this invention.

Figure 9 is a view similar to Figure 8 and illustrating the manner in which cam grooves and guide pins direct the dies between open and closed positions.

Figure 10 is a fragmentary cross-sectional view taken along the line X—X of Figure 9.

As shown on the drawings:

In the embodiment 10 of the invention shown in Figures 1 to 7 inclusive, a heavy rigid die block 11 has an open-topped close-bottomed recess receiving a pair of dies 12, 12. A separator 13 is mounted on top of the die block 11 to spread the dies 12, 12 apart during the discharge step of the process. Circular metal disks 14, 14 are provided for maintaining the dies 12, 12 in alignment. A punch 15 is slidably mounted through a stripper bar 16 and is effective to force a billet B into conformity with the die cavity of the dies 12, 12 while piercing an end face of the billet B.

The recess of the die block 11 has tapered end walls 11*a*, 11*a* and vertical side walls 11*b*, 11*b* together with a flat horizontal bottom 11*c*. The end walls 11*a*, 11*a* diverge from the bottom wall 11*c* at a wedging angle. Each wall 11*a* preferably diverges at least 8° from the vertical. The taper is continuous from the top to the bottom of the recess.

The dies 12, 12 have tapered end walls 12*a*, 12*a* mating with the end walls 11*a*, 11*a* and have vertical side walls 12*b*, 12*b* mating with the side walls 11*b* of the die block. The dies also have flat horizontal bottom walls 12*c* lying in spaced relation above the bottom wall 11*c* of the die block. These bottom walls 12*c* extend inwardly from the tapered end walls 12*a* to rounded surfaces 12*d* which curve inwardly and upwardly to flat mating walls 12*e*. The mating walls 12*e*, 12*e* are abutted firmly together by the wedge relationship of the end walls 11*a* and 12*a*. It will therefore be noted that the parting line between the dies 12, 12 is between the tapered walls of the die block and the taper of the die block is toward this parting line for maintaining a wedged-together abutting condition of the dies when the same are urged toward the bottom of the recess in the die block. The dies will be abutted together by the wedging walls before they are bottomed on the wall 11*c* of the die block so that this wall will not resist the wedging action.

Each die 12, 12 has a semi-recess in its mating face 12*e* thereof. These semi-recesses of the dies coact to define a cylindrical entrance hole or passageway 17 and a shaping cavity 18. The entrance hole or passage 17 extends downwardly from the top wall of the dies to the top of the shaping cavity 18 and has a diameter sized for snugly receiving the punch 15. The shaping cavity 18 is wider than the passage 17 and a top

shoulder 19 is provided between the passage and cavity. As illustrated, the shaping cavity 18 has the contour of a drill bit.

The metal billet B from which a drill bit DB is formed fits into the hole or passage 17 as best shown in Figure 3 and is bottomed on the bottom of the die cavity 18. The punch 15 acts on this billet B as shown in Figure 4 to form the drill bit DB conforming with the shape of the cavity 18. At the same time, however, the leading end of the punch 15 pierces the top end of the billet to form a shank recess 20 in the drill bit DB. The drill bit DB becomes impaled on the leading end of the punch.

During the downward stroke of the punch, the mating faces 12*e*, 12*e* of the dies are continually forced toward each other by the tapered end walls of the die block so that the die cavities are continuous and the parting line between the dies is tightly closed to eliminate flashing of billet metal between the dies.

The side walls of the dies 12, 12 each have semi-circular recesses 12*f* therein near the bottoms of the dies. These recesses extend symmetrically on opposite sides of the parting line between the dies and have their centers on the parting line. The disks 14 fit in the recesses 12*f*, one-half of each disk being seated in the semi-recess of each die. The disks are effective to hold the dies in alignment and also function as turning axes for tilting of the dies during the discharge operation.

After the punch has reached the end of its forging stroke, it is retracted upwardly and carries the drill bit DB therewith. This retractive movement of the drill bit raises the dies relative to the die block since the top of the drill bit will act against the shoulder 19 of the die cavity. Raising of the dies relative to the die block, of course, moves the dies to the enlarged upper portion of the die block recess and, since the dies are top-heavy, being thicker at the top, the same will ride on and tilt about the tapered walls of the die block as best shown in Figure 5. As the dies tilt on the tapered walls 11*a* of the die block, the die cavity is opened up so that the drill DB is readily removed from the dies as illustrated in Figure 5.

In order to initiate separation and tilting of the die blocks during the retraction of the punch and drill bit, the separator device 13 is provided on the die block 11. This device 13 has a finger 13*a* overlying the parting line between the dies 12, 12. The finger, as shown in Figure 3, is of triangular cross section with a pointed end arranged to enter the parting line so that, as the dies are raised, the diverging sides thereof will separate the dies. This device 13 prevents any possible adherence of the dies during the retraction step, so that the dies cannot be simultaneously lifted straight up out of the die block recess without riding on the walls 11*a* of the recess. The device 13 can be affixed to the top of a side wall of the die block as shown in Figure 1.

As shown in Figure 6, when the punch 15 raises the drill bit DB up to the stripper bar 16, this bar stops further upward movement of the bit and the punch is retracted through the bar and out of the bit. In the meantime the dies, upon being freed of the drill bit, fall by gravity back into the recess of the die block 11 and automatically come together for the next forging operation. Since the drill bit is larger than the entrance hole or passageway 17 of the closed dies 12, 12, it will rest on top of the dies after it is stripped off of the punch. In the forging machine equipped with the dies, punch, and stripper bar the feature of supporting the stripped-off drill bits on the closed dies produces a convenient arrangement since the stripped-off bits can then be automatically removed by a blast of air, by a discharge arm, or any other suitable mechanism.

In the modified embodiment 10*a* of the invention shown in Figures 8 to 10, parts identical with parts described in Figures 1 to 7 have been marked with the same reference numerals. As shown in Figures 8 and 9, the disks 14 of the embodiment shown in Figures 1 to 6 are eliminated and the die blocks 12, 12 are guided between open and closed positions by means of pins 21 projecting from the side walls of the die block into grooves 22 in the side faces 12*b* of the dies. These grooves 22 form cam tracks to guide the dies from the abutted-together closed position shown in solid lines in Figure 9 to the separated open position shown in dotted lines in Figure 9. The pins are positioned near the upper ends of the die block 11 as shown in Figure 9.

The rounded surfaces 12*d* of the dies 12, as best shown in dotted lines in Figures 7 and 9, coact to provide turning fulcrums for the dies as they are tilted back on the tapered walls 11*a* of the die block and make possible a greater angle of tilt for the dies. Thus the cutaway rounded corners permit the dies to tilt apart along a rounded fulcrum and, of course, the disks 14 or the pins 21 hold the dies in aligned relationship so that one die cannot become offset relative to the others.

The arrangement of Figures 8 to 10 operates identically as described in connection with Figures 1 to 7.

From the above descriptions it should be evident that the invention provides a method and apparatus for shaping articles in a die cavity and for removing the shaped articles from the cavity by automatically separating die segments during the removal step.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. The method of shaping articles in a die cavity defined by a plurality of die segments which comprises placing a billet in the die cavity, pressing a punch against an end of the billet, simultaneously piercing the billet with the punch and shaping the billet into conformity with the die cavity to impale a shaped article on the punch, retracting the punch and article impaled thereon, separating the die segments during said retracting step to open up a discharge path for the article, guiding the die segments back to closed position, stripping the article from the punch, and depositing the stripped article on top of the die segments.

2. The method of forging an article in a multi-segment die which comprises wedging the die segments toward each other, inserting a billet into the cavity defined by the wedged together segments, forcing a punch into said cavity against the end of said billet to simultaneously pierce and shape the billet into conformity with the die cavity to produce a shaped article impaled on the punch, retracting the punch with the article impaled thereon, separating the die segments

during said retracting step to open up the die cavity thereof and provide a discharge path for the article, guiding the article-freed die segments back into wedged-together relation, stripping the article from the punch, and depositing the stripped article on the die segments.

3. The method of making articles with hollow shanks in a multi-segment die which comprises seating the die segments in a die block having converging walls, pressing the segments toward the converging ends of said walls to wedge the segments together, depositing a billet in the die cavity of the wedged-together segments, forcing a punch against an end of said billet to deform the billet into the shape of the cavity while simultaneously piercing said end to impale the shaped member on the punch, raising the impaled article out of the die block, simultaneously spreading the die segments to open up the die cavity for discharge of the article, guiding the spread segments back into the die block into wedged-together relationship, stripping the article from the punch, and depositing the stripped article on top of the wedged-together segments.

4. Die forging apparatus comprising a die block, a plurality of die segments in said die block, said die block having tapered walls arranged to wedge together said die segments, a spreader member on said die block overlying the parting line between said die segments to separate the segments as they are raised out of the die block, fulcrum means for said dies forming a tilting axis for the spreading dies, a punch having a leading end adapted to enter said dies, and a stripper bar receiving said punch therethrough for removing an article impaled on the punch.

5. Die forging apparatus comprising a die block having an open-topped closed-bottomed recess with tapered end walls converging toward the bottom of the recess, a pair of die segments having flat mating end faces with fragmental die cavities therein and having tapered opposed end faces coacting with the tapered end walls of the die block recess to wedge the mating faces of the die segments together, a punch adapted to enter the die cavity of the wedged-together die segments for acting on a work piece therein and having a leading end arranged to pierce the work piece to impale the article shaped therefrom on the punch, a stripper bar slidably receiving the punch therethrough, and fulcrum means for guiding the die segments against said tapered end walls of the die block as the shaped article is retracted from the die cavity for separating the die segments to open up the die cavity.

6. Die forging apparatus comprising a die block having a cavity with opposed tapered walls, a pair of die segments seated in said cavity having tapered walls coacting with the walls of the cavity for urging the segments together, said segments coacting to define a shaping cavity and an entrance hole, means on the die block overlying the parting line between the dies to separate the dies as the same are raised out of the die block, said dies having semi-circular recesses in the side faces thereof with centers on the parting line between the dies, and circular disks seated in said recesses to hold the dies in aligned relationship as the same are moved into and out of the die block.

7. A die forging apparatus comprising a die block having a recess with tapered end walls and vertical side walls, a pair of complementary die segments having tapered end walls coacting with the tapered walls of the recess and vertical side walls coacting with the vertical side walls of the recess, said die segments coacting to define a shaping die cavity and an entrance hole thereto, a spreader device on said die block overlying the parting line between said die segments to separate the segments and open up the die cavity as the segments are raised out of the die block, and means carried by the die segments for holding the segments in aligned relationship to prevent one segment from being offset relative to the other as the segments are raised from and lowered into the recess of the die block.

8. Die forging apparatus comprising a die block having a cavity with converging end walls, a pair of die segments seatable in said cavity and having tapered end walls cooperating with said converging end walls to wedge the segments together as the same are forced into the cavity, pin means projecting into said cavity, and cam grooves in said die segments for receiving said pins to guide the segments between a spread-apart open position and a closed wedged-together position.

9. Drill bit forging apparatus comprising a die block having an open-topped recess with converging end walls, a pair of die segments seatable in said recess and arranged to be wedged together when forced into the recess, a punch having a leading end arranged to enter the die cavity of the die blocks, said punch receiving a work piece thereon to carry the work piece therewith, a stripper bar slidably receiving the punch therethrough, and guide means for separating the die segments as the work piece is raised out of the die block, said die block guiding said segments back into closed position after said work piece is removed therefrom, and said stripper member arranged to separate the work piece from the punch for deposit on the closed die segments.

10. The method of die forging drill bits or the like which comprises providing a pair of mating dies with complementary die cavities in the mating faces thereof, seating said dies in a die block having tapered walls opposite the mating faces of the dies for wedge action on the dies to hold the mating faces in abutted together relation, pressing a plunger into engaging relation with a work piece in said die cavity to connect the plunger and work piece and to shape the work piece into conformity with the cavity, retracting the plunger from the dies to raise the shaped article therewith and cause the article to simultaneously raise the dies relative to the die block, and spreading the dies as they rise to thereby open up the die cavity for discharge of the shaped article.

11. The method of making shaped articles which comprises urging the mating faces of a plurality of dies together to form a die cavity with a restricted entrance hole partially defined by each die, pressing a work piece in the die cavity of said dies to spread the work piece laterally of said hole into conformity with said die cavity and form a shaped article wider than said hole, forcing the shaped article toward said hole, and utilizing said force to effect separation of the mating faces of the dies to open up said hole for forming a discharge path from the die cavity accommodating discharge of the shaped article.

12. A die construction comprising a strong rigid die block having a recess with vertical side walls and end walls converging from the top of the block at a minimum angle of about 8° from the vertical, a pair of die segments fitting in the recess in said block and having vertical side walls

and tapered end walls coacting respectively with the vertical side walls and converging end walls of the recess, said die segments having mating end faces with segmental die cavities therein arranged to coact in forming a closed die cavity when the mating faces are abutted together, each die segment having a semi-circular recess in each vertical side wall thereof and the semi-circular recesses in adjacent side walls mating to form a circular recess when the dies are closed, a circular disk in each of said mated circular recesses forming a tilting axis for the dies while holding the dies in aligned relationship, and said dies having rounded surfaces joining their mating faces with the bottom ends thereof to facilitate tilting of the dies about the circular disks.

13. Die forging apparatus comprising a die block, die segments seatable in said block, said segments having complementary semi-recesses in the sides thereof near the bottoms thereof and communicating with the parting line between the segments, and a disk in said recess adapted to hold the die segments in alignment in said

block while forming a fulcrum accommodating tilting of the segments thereabout as the segments are moved out of the die block.

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