A. L. WARNER.

PROCESS OF FORGING CRANK SHAFTS AND SIMILAR ARTICLES.

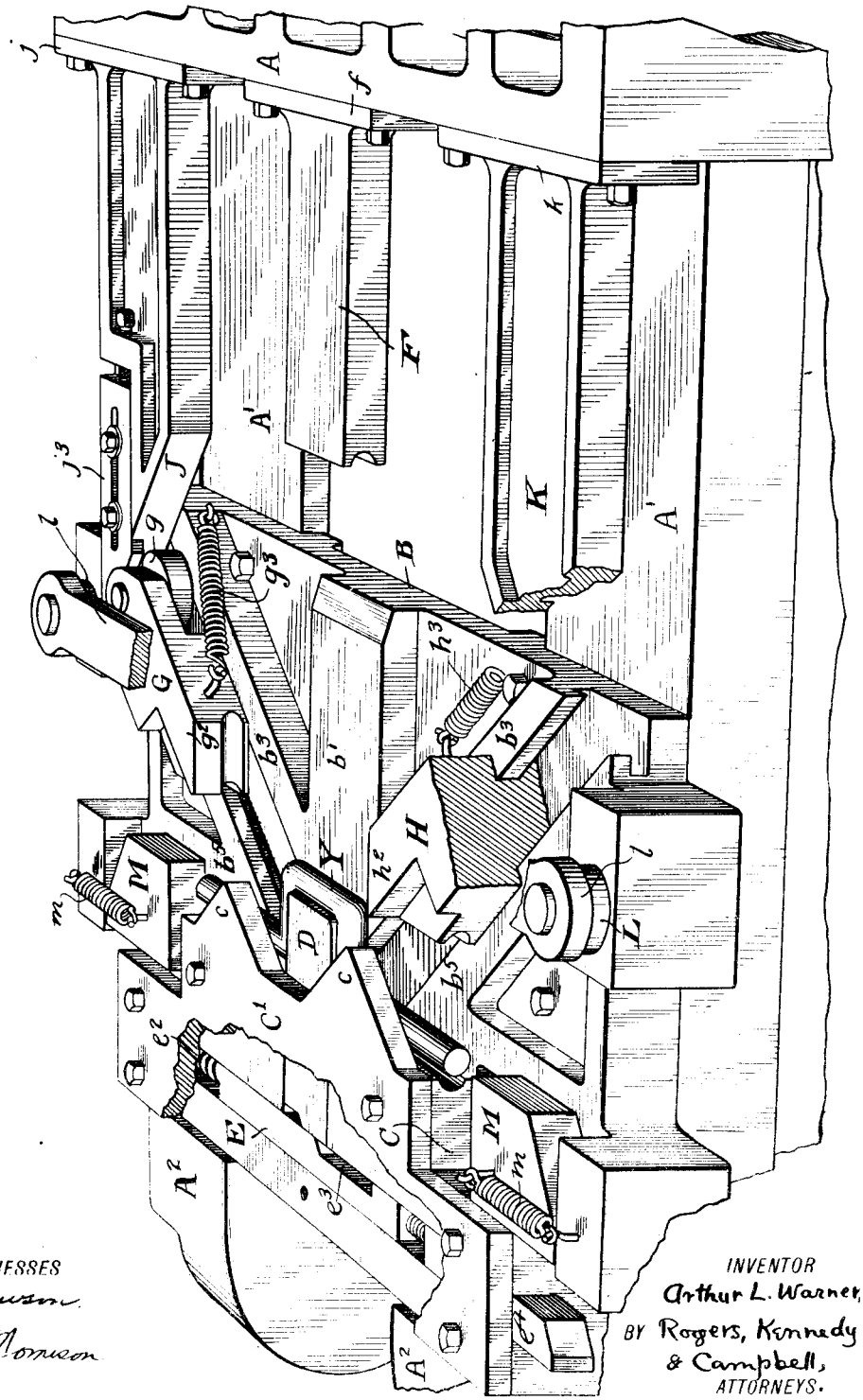
APPLICATION FILED AUG. 28, 1914.

1,181,703.

Patented May 2, 1916.

2 SHEETS—SHEET 1.

Fig. 1



WITNESSES

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2 SHEETS—SHEET 2.

Fig. 3.

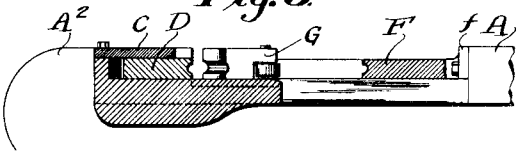


Fig. 2

Fig. 4

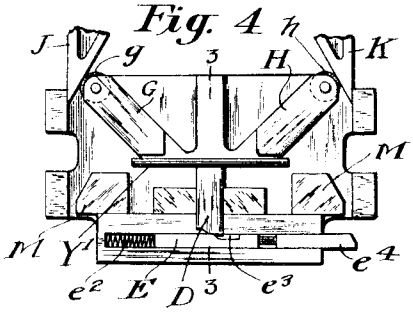


Fig. 7.

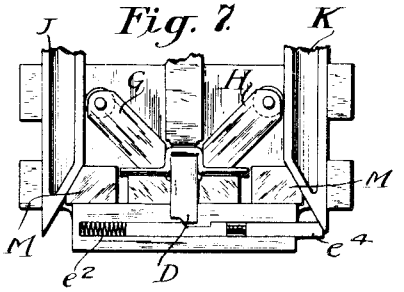


Fig. 11.

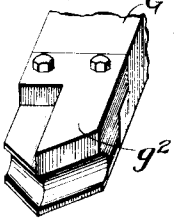


Fig. 5

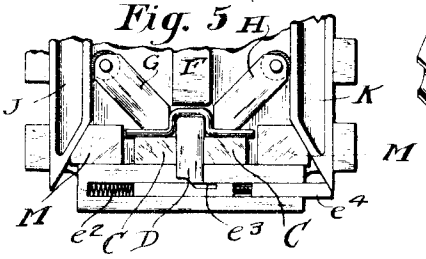


Fig. 8.

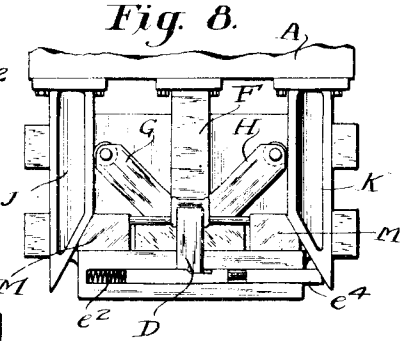


Fig. 9.

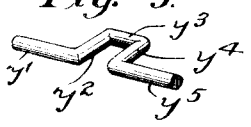


Fig. 6.

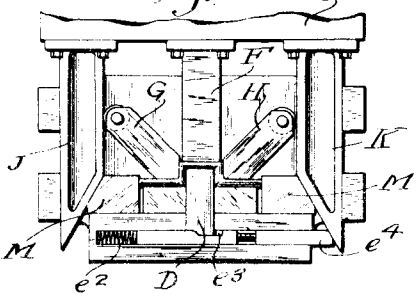
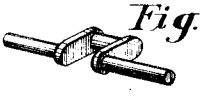


Fig. 10.



WITNESSES

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ARTHUR L. WARNER, OF MOLINE, ILLINOIS, ASSIGNOR TO WILLIAMS, WHITE & COMPANY, A CORPORATION OF ILLINOIS.

PROCESS OF FORGING CRANK-SHAFTS AND SIMILAR ARTICLES.

1,181,703. Specification of Letters Patent. Patented May 2, 1916.

Original application filed June 24, 1911, Serial No. 635,112. Now Patent No. 1,108,954, dated September 1, 1914. Divided and this application filed August 28, 1914. Serial No. 859,063.

To all whom it may concern:

Be it known that I, ARTHUR L. WARNER, a citizen of the United States, residing at Moline, in the county of Rock Island and State of Illinois, have invented certain new and useful Improvements in Processes of Forging Crank-Shafts and Similar Articles, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to method of forging crank-shafts or analogous articles which comprise in addition to the main portion of the shaft a crank wrist or pin portion offset from the shaft line and at least one, or preferably, two webs or arms extending integrally between the wrist and main portion of the shaft.

The general object hereof is to enable the manufacture of crank-shafts in an economical and efficient manner so as to afford crank-shafts of high degree of strength, uniformity and other desirable qualities.

Particularly it is an object hereof to enable the manufacture of crank-shafts in quantities in such way as to afford full stock at the corners of the bends of the crank-shaft, this being one of the problems with which forge shops have had to contend.

It is a further object hereof to enable the above recited objects to be carried out in the manufacture of a crank-shaft in substantially a single operation so as to thereby greatly increase the output.

Other objects and advantages will appear in the hereinafter following description or will be apparent to those skilled in the art.

In a general way it may be stated that the method constituting the present invention consists in first bending portions of a bar of metal in such manner as to form the crank arms and wrist with an excessive crank throw and thereupon displacing the wrist relatively toward the shaft line to secure the desired crank throw, thus causing the metal to flow into the corners of the bends.

The present method will be described more in detail hereinafter in connection with the description of a convenient form of apparatus for carrying out such method.

No claim is herein made for the illustrated apparatus, since the same has been made the subject of a separate prior application, of which the present application is a division. Said prior application has now been patented, No. 1,108,954, of September 1, 1914.

A detailed description of the present process will be postponed until a convenient apparatus for carrying it out has been referred to.

In the accompanying drawings forming a part hereof, Figure 1 is a perspective view, taken generally from the right side of the apparatus, its front end being at the left hand of the figure, certain parts being omitted for clearness of illustration. The finished crank is ready to be removed, preparatory to the insertion of the heated straight bar or blank which is to be formed into the succeeding crank shaft. Fig. 2 is a right-hand elevation, indicating a convenient mechanism for reciprocating the crosshead of the bulldozer. Fig. 3 is a central lengthwise section. Figs. 4, 5 and 6 are top views, more or less diagrammatic, indicating different stages in the operation. The top plate C′ of the anvil block C, the guides for the dies and other parts are omitted. Fig. 4 shows the initial position. The heated straight bar Y′ is in place and the interior anvil D^3 is locked in inward position. Fig. 5 shows the diagonal dies having moved inward, thus producing the four bends in the shaft, or two bends, if the crank has but one web. Fig. 6 shows the wrist die and the end blocks forced inward, and the interior anvil withdrawn to its outward position. In this operation all the corners are upset. This stage of operation is followed by the reversal of the parts to the position shown in Fig. 1. For shafts with flat instead of round webs the apparatus will be modified according to Figs. 7 and 8, which correspond with Figs. 5 and 6. Fig. 9 represents the crank shaft forged on the apparatus of Figs. 1 to 6. Fig. 10 represents the crank shaft forged on the apparatus of Figs. 7 and 8. Fig. 11 indicates a shaper with means by which its face may be adjusted or renewed.

By the present invention a crank shaft is made partially by bending and partially by upsetting in one continuous operation. This affords the important advantage that the natural grain or fiber of the metal lengthwise of the shaft is not disturbed or

distorted to any substantial extent. Consequently a stronger crank shaft is obtained than with a drop forge.

The terms to be used herein first require some explanation. The shaping members or dies of the apparatus will sometimes be called shapers. They give shape to the crank shaft. In some cases the shapers are active dies, which advance to press the material. Otherwise they are passive and give shape by resisting active dies. The passive dies will in the description be referred to as anvils. This, however, is only for convenience of explanation. It is understood that any die action is only relative. Mechanically a passive anvil resisting an active die is the same as though the anvil advanced toward the die. A crank shaft consists of the following: The shaft proper or the two ends y' y^5, Fig. 9, extend along the line of the shaft. The crank webs y^2 y^4 whether there be one or two connect the shaft proper with the wrist y^3. Forward means toward the front of the apparatus. Inward and outward mean toward and from the metal being forged.

The operation begins by bending the metal to the general shape of the crank shaft, and the operation continues by causing the metal's upsetting for completely filling out the corners. The bending is done by the inward movement of shapers, which after bending become passive and give shape during the upsetting. The upsetting is done by the wrist die moving toward a yielding anvil, supplemented by forcing the ends of the shaft inward. The metal is thus made to flow into the corner spaces of all four of the bends. The apparatus for carrying out of this operation comprises an interior anvil shaped to extend between the webs of the forged shaft, together with two or more movable dies converging toward the anvil. There are shown three dies, a wrist die and two diagonal dies at the side. The diagonal dies effect the bending, and their operation is followed by that of the wrist or central die. The latter moves directly toward the aforesaid anvil, which is constructed so as to yield. Thus the die and anvil move together, and cause the metal to be upset in the manner stated.

The specific illustrated apparatus will now be referred to.

The reciprocating crosshead A moves along a stationary frame, which may consist of two side frame pieces A′, A′. At the front end of the machine is the abutment opposed to the crosshead A. The abutment may consist of a pair of upstanding lugs A^2, A^2, as shown. The forging apparatus of this invention is located entirely between the crosshead and the abutment. This apparatus, in addition to the dies and anvils, comprises a heavy casting or bed B. This should be bolted down upon the frame of the bulldozer. It may have longitudinal ribs at its under side to fit snugly between the bulldozer frame parts A′, A′. This gives an extremely rigid permanent connection. The apparatus preferably stands horizontally, and the upper side of the bed B is generally flat with raised portions b', b^3 and b^5 serving as guides. The bent crank shaft Y is shown in Figs. 1 and 5 to 10, and the heated straight rod or blank Y′ from which it is made, is shown in Fig. 4. The finished crank comprises in succession shaft part y', web y^2, wrist or pin y^3, web y^4 and shaft part y^5. At the front of the heated blank are the passive shapers or anvils C and D. At the opposite side are the active dies F, G, H. The main anvil C is stationary, although it should be so secured as to permit adjustment when desired. A cover plate, C′, confines certain parts within the anvil C. This top plate is omitted from Figs. 4 to 8. The anvil C is recessed centrally to form a longitudinal way for anvil member D. This divides the anvil C into two shaping portions, which may be called end shapers. The anvil member D extends through the recess in anvil block C, and considerably beyond it, as seen in Figs. 1 and 4. It lies between the two webs and wrist of the finished crank, and gives them their proper final shape. The main anvil C and interior anvil D together constitute a passive shaper for opposing the movable dies. Relative adjustment is easily permitted for altering the dimensions or throw of the crank shaft. The anvil D is adapted to be substantially fixed at certain times, and shiftable at other times. A strong spring might be employed to hold it in the inward position of Figs. 1, 4, 5, and 7, which would subsequently permit yielding. However, a mechanical stop is preferred. For example, the stop E fitted in a transverse way in the anvil C. This stop is in its right-hand position in Figs. 1 and 4, being held there by spring e^2. In this position the anvil member D is secured in its inward location. If the stop E be forced to the left, its recess e^3 admits the anvil D, so that the latter can recede the proper distance. The anvil D is to be held in its inward position as in Figs. 1 and 4, during the formation of the bends in the crank shaft. The dimensions are calculated to give the crank shaft a throw greater than is finally desired. The operation is, that after the bending is complete, the anvil D is permitted to recede, while the central die forces the crank wrist to its proper final position. In this way sufficient metal is afforded for filling out the corner spaces at the bends.

While the stop E may be operated by hand, it may also be operated automatically as follows: It has at its right end, an adjustable cam piece e^4 which is adapted to be contracted by cam K, afterward to be described, for forcing the stop leftwise at the proper moment.

We come now to the movable dies. The two diagonal dies G, H, may be set practically at forty five degrees. This direction gives good access for the purpose of bending. These diagonal benders, together with the central wrist die F, all converge when moved inwardly toward the anvil. The three converging dies all take their motion from the reciprocating cross-head A of the bulldozer. The central die F may be merely attached to the crosshead A by a foot f. The die F is of such length as to come into operation only after the diagonal dies have completed the bending. For actuating the diagonal dies, there may be cam members J, K, which are both attached by their feet j, k, to the crosshead A. The inclined front ends of the cam members J, K, act upon rollers g, h, carried on the diagonal sliding dies G, H. When the crosshead moves forward, the cams J, K, cause the dies G, H, to move diagonally inward upon the blank or straight bar Y', Fig. 4, so as to produce the bends in it as in Fig. 5. The cams J, K, are so shaped that when their inclined ends have done the work of moving the dies, their side surfaces hold the dies G, H, locked inwardly, as seen in Fig. 5, so that the dies become substantially stationary, and able to serve as passive shapers during the upsetting. The central die F has no bending to perform. It is so formed as to give the proper shape to the crank wrist. The die F may be constructed to be readily adjustable in length for crank shafts of varying dimensions.

All of the dies F, G, H, may have removable and adjustable faces as in Fig. 11, so as to permit replacement when worn, or variation of dimensions. Guideways are necessary for the diagonal dies G, H. The face of each of these dies consists of two slanting surfaces, one adapted to press the metal toward the interior shaper D, and the other toward the end shapers or anvil C. Each die is guided by its shank, which engages an undercut slideway formed between the raised portions or ribs b^3, b^5 of the bed. At the final or critical movement of the dies G, H, it is preferred to give them further guidance by means of a pair of triangular projections c, which stand out from the top plate C' of the anvil block. Each die has a raised projection g^2, h^2, which contacts the projection c as the dies slide inward. The depressed part of each die slides under the projection c. They are thus most effectively supported to resist displacement during any part of the forging operation. The outward or idle position of each die G, H, is sufficiently rearward to permit the original straight bar or blank to be inserted in forging position. Any means may be employed for moving the dies outwardly, and springs g^3, h^3 are shown. To move the dies G, H, inwardly, the cams J, K, contact the rollers g, h, as before explained. Each roller g, h, is simply mounted on a vertical pin extending from the lower part of the diagonal die to an overhanging portion above the roller. There exists a side thrust, tending to force the cams J, K, apart while driving the dies. This is met by a pair of rolls L, L, lying outside of the cams while across the top of the machine, from one roll L to the other, is a rod l, which gives the necessary bracing. The dies F, G, H, are timed so that G and H first strike and bend the metal to substantially the shape shown, after which the dies G and H become stationary, while the die F comes into action at the wrist portion y^3 of the crank. The die F tends to drive the wrist inwardly toward the shaft line. It is at this point in the operation that the stop E is shifted to the left, to allow the anvil member D to be pushed outwardly, as the die F moves inwardly. This substantially displaces the crank wrist toward the shaft line, to its desired final position, and causes the flow of metal aforesaid, into the corner spaces. In this way, the corners may not only be filled out to make them as strong as other parts, but, in fact, the corners may be rendered thicker and stronger than elsewhere, if so desired.

The actual shape of the webs of the finished crank shaft, will depend upon the shape of the side faces of the diagonal dies and the anvil member. These are concave in Figs. 1, 3, 4, 5 and 6, resulting in a round web crank as in Fig. 9. By making the anvil and die faces flat as in Figs. 7 and 8, the crank webs may be converted to a flat form, as in Fig. 10, which is a desirable type of crank shaft. The changes are made by removing and replacing the faces of the dies, and making the necessary adjustments of motion. Greater pressure is required in making flat webs than round webs, and the projections c, c, before referred to, are provided especially for this use.

The upsetting operation is rendered more perfect and complete at all four of the bends by the following mechanism: An upsetting block M is shown at each side of the machine. These slide laterally and have spring m to withdraw them outwardly. The blocks may be slidably connected in any way to the bed. The purpose of these blocks is to press inwardly at the proper time upon the two ends y' y^5 of the shaft. A convenient way to automatically move the blocks is by employing the same cams J, K, which have

previously caused the inward movement of the dies G. H. The corner of each block M is beveled to admit the forward end of each cam, so that just before the cams reach the limit of their movement, they operate to wedge the blocks M, M, toward each other. The wedging action of cam J can be adjusted by means of an adjustable attached piece j^3, which contacts the upsetting block M sooner or later, according to its position. The two ends of the shaft are thus bodily forced inward. In this way the plastic metal is forcibly acted upon, and caused to flow as required to completely fill out the corner spaces. The parts should be so designed that the blocks M, M, move inwardly at the same time the die F is in operation, so that the upsetting in all of the corners is simultaneous.

Each of the cams J, K, is seen to perform three operations. First, it moves its diagonal die inwardly, and thereafter holds it rigidly in place. Secondly, the cam shifts the stop E to the left to permit the anvil member D to recede, and at about the same time forces the upsetting block M inwardly; while at the same time the die F comes into operation pushing the anvil member D ahead of it. Thus, from the crosshead of the machine, all the operations are performed. Manifestly, the mechanical connections between the several parts may be indefinitely varied.

The described production of the complete crank shaft will be seen to constitute a single operation. This includes, not only the formation of the wrist and webs and the four bends, but also the filling out of all of the corners.

As compared with the old drop forging process, this invention enables a crank shaft to be manufactured from material of small diameter, because after the operation of the present invention, neither enlargement of the corners, nor reduction of the diameter of the shaft is necessary. Thus, both labor and material are saved.

It will be advantageous to re-state the complete operation of the described apparatus.

The crosshead A being in its withdrawn or rearward position, the dies F, G, H, are retracted so far as to permit the straight blank to be inserted between the dies and the anvil. The middle anvil member D stands in its inward or rearward position, owing to the springs e^2 forcing the stop E to the right, and thus wedging the anvil member inward. The upsetting blocks M are held outward by their springs. Fig. 4 represents this condition. The forward movement of the bulldozer crosshead will now commence, giving a blow or pressure. First the diagonal dies G, H, strike the heated bar, causing it to be bent inwardly into the general form indicated in Fig. 5 or Fig. 7. At this point the cams J, K, clear the dies G, H, so as to hold them stationary as in Figs. 5 and 7. The cam K reaches the stop E and commences to shift it to unlock the anvil member D as in Figs. 5 and 7. As the crosshead continues to move forward, the die F comes into play, also the cams J, K, move the upsetting blocks M inward. As the die F presses on the crank wrist, the anvil member D recedes, and the upsetting blocks M move inwardly. The receding of the anvil member D is limited. At the extreme limit of the crosshead movement, a final pressure at all parts is brought to bear, to powerfully squeeze the heated metal and fill it out to the predetermined accurate shape desired. This stage is indicated in Figs. 6 and 8. The forward movement of the crosshead might be abrupt or gradual, and might even consist of a series of impulses. The crank shaft being in completed form as in Figs. 6 and 8, the crosshead withdraws completely to the rear. This condition is illustrated in Fig. 1. The finished crank shaft may now be taken out and a new heated blank inserted.

A valuable part of this invention is that extensive upsetting may be obtained. Actual collars may be produced at the point where shaft and web meet. Adjustments may be easily made in many obvious ways. Alteration of dimensions may be obtained by replacing the dies and movable anvil. A deeper or shallower recess in the stop E will change the crank throw and the extent of upsetting. The size or extent of movement of the upsetting blocks M determine the amount of upsetting at the lower bends.

It will be seen that a method has been described attaining the objects and advantages and operating on the principles of the present invention. Since the detail of the several steps and the relative order of performance thereof and other described features may be varied without departing from the main principles, there is no intention to restrict the present invention to such features excepting as set forth in the appended claims.

What is claimed is:

1. The method of forging crank shafts consisting in bending the heated bar of metal into the general shape of the crank shaft while giving support thereto at the interior of the wrist and webs, and immediately, before any substantial cooling of the bar, partially withdrawing such support and simultaneously applying exterior pressure to give the final shape to the wrist and webs and to upset metal into the corners of the bends.

2. Method of making a crank shaft from a bar, which method consists in supporting the wrist section of the heated bar, bending

the bar adjacent to such supported section to produce the webs and so as to give the wrist an excess throw, giving support to the webs at their exterior sides, and forcing the wrist in a direction toward the axis and simultaneously withdrawing its support in the same direction, whereby to give the crank shaft its final desired throw.

3. The method of making crank-shafts which consists in first bending portions of a bar of metal in such manner as to form the crank webs and wrist with an excessive crank throw, and thereupon displacing the wrist relatively toward the shaft line to secure the desired crank throw thus causing the metal to flow into the corners of the bends.

4. The method of making crank-shafts which consists in first bending portions of a bar of metal in such manner as to form the crank webs and wrist with an excessive crank throw, and thereupon displacing the wrist relatively toward the shaft line to secure the desired crank throw while confining the webs, thus causing the metal to flow into the corners of the bends.

5. The method of making crank-shafts which consists in first bending portions of a bar of metal in such manner as to form the crank webs and wrist with an excessive crank throw, and thereupon displacing the wrist relatively toward the shaft line to secure the desired crank throw while confining the webs, thus causing the metal to flow into the corners of the bends, and shaping the corners during such flow into the corners.

6. The method of making crank shafts which consists in first bending portions of a bar of metal in such manner as to form the crank webs and wrist with an excessive crank throw while supporting the interior side of the wrist, and thereupon withdrawing such support and displacing the wrist relatively toward the shaft line to secure the desired crank throw, thus causing the metal to flow into the corners of the bends.

7. Method of forging crank shafts and the like from a heated metal bar wherein the heated bar is doubly bent in a manner for producing the web and wrist (pin) portions with an excessive radius or throw of crank, immediately followed by relative displacement of the crank wrist and the shaft line toward each other in a manner to secure the correct radius or throw of crank and at the same time cause the excess heated metal to flow into the corner spaces of the bends.

In testimony whereof, I have affixed my signature in presence of two witnesses.

ARTHUR L. WARNER.

Witnesses:

HARRY AINSWORTH,

JOHN W. LIVINGSTON.