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M. A. AMMON

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CLUSTER GEAR AND METHOD OF MANUFACTURE THEREFOR

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2 Sheets-Sheet 1

INVENTOR.

MARK A. AMMON

BY Charles M. Piger

ATTORNEY.
My invention relates to forging, and more particularly to forging of an integral cluster gear, or similar article, having a plurality of gears integral with a hub and a groove between adjacent gears.

With respect to a cluster gear designed for shifting movement along a speed-change transmission shaft, the groove between adjacent gears is usually comparatively narrow to receive a suitable shifting fork; and the narrowness of such groove presents the problem of forming adjacent gears with proper flow line characteristics. This is so because it is extremely difficult to provide in the forging apparatus a narrow or thin insert collar or ring adapted to form a groove during forging, which is of a material that will not deform under the forging temperature. Obviously, such deformation is objectionable inasmuch as, if occurring, it would preclude proper formation of the parts.

Heretofore, this difficulty was overcome by manufacturing such cluster gear by a forging machine method which broadly comprises feeding a relatively long bar of the stock in a horizontal direction, upsetting the stock to form a blank for one of the gears and a shank portion for another adjacent gear, and then subsequently upsetting the shank portion by folding the material adjacent such first formed blank, against itself, to form the blank for the adjacent gear, and a lap or fold between such blanks, which is subsequently machined out. In such forging machine, the dies part longitudinally or axially with respect to the stock; and the blank for the smaller gear of the cluster gear is formed prior to the formation of the lap and the blank for the larger gear. As a result, the forging parting line resulting from the dies will extend longitudinally or axially which is not at all to be desired, as this does not enable best flow line characteristics. Furthermore, the formation of the lap and the blank for the larger gear after formation of the lap and the blank for the larger gear after formation of the blank for the smaller gear, is not entirely satisfactory because such procedure makes it extremely difficult to control the location of the lap which frequently forms in the blank portion for the larger gear, resulting in weakening of the structure when the lap is machined out.

My invention is designed to overcome the above described problems and has as its objects, among others, the provision of an improved and economical forging method for a cluster gear or similar article, whereby the formation of the described lap is accurately controlled, and proper flow line characteristics are imparted to the gear to thus form an improved article; and which may also be employed to advantage for formation of a cluster gear or similar article which is not formed with such lap, during manufacture, but to which favorable flow line characteristics are imparted by the method. Other objects of my invention will become apparent from a perusal of the following description thereof.

In general, my invention comprises first forming a blank for the larger gear of such cluster gear, by die means which applies axial pressure and provides a parting line which extends transversely with respect to the peripheral or gear tooth face of the blank intermediate the sides thereof, and then applying pressure on the material in an axial direction to upset the material adjacent the blank and form another gear blank for a smaller gear. Because of the arrangement of the parting line in the manner related, good flow line characteristics are imparted to the larger gear. When the cluster gear is to have the comparatively narrow groove, a collar is employed about the material to be upset for formation of the blank for the smaller gear adjacent the blank for the larger gear, and during such upsetting a lap is allowed to form. By this means, the location of the lap may be accurately controlled so as not to come within the blank for the larger gear. Substantially the same method is employed for a cluster gear which has a relatively wide groove between adjacent gears, except that the blank for the smaller gear is formed by upsetting the material adjacent the blank for the larger gear, within a split collar or die having an internal ring to form the wide groove, and which may be readily removed after formation of the smaller gear.

Reference is now made to the drawings for a more detailed description of the invention.

Fig. 1 is a longitudinal sectional view of one form of a narrow groove cluster gear, chosen for purposes of illustration, to which the method of my invention is applicable.

Figs. 2 through 8 are schematic views illustrating in progressive stages the method of forming the gear of Fig. 1.

Of these figures:

Fig. 2 is a perspective view of a stock or mass of material from which the gear is made.

Fig. 3 is an elevational view of such mass after it is given a preliminary shaping.

Fig. 4 illustrates a roughing impression made by a forging hammer.
Fig. 5 illustrates the final hammer forging impression.

Fig. 6 illustrates the blank in the apparatus employed for effecting formation of the blank for the smaller gear and the previously mentioned lap, just prior to the formation thereof. Fig. 7 illustrates the apparatus and the shape of the blank of Fig. 6, after formation of the blank for the smaller gear and the lap.

Fig. 8 illustrates the blank of Fig. 7 removed from the apparatus and rough machined; the blank being shown in longitudinal section, and with a portion of the apparatus and the shape of the blank of Fig. 6, after formation of the blank for the smaller gear and the lap.

Fig. 9 is a longitudinal sectional view of one form of a wide groove cluster gear, chosen for purposes of illustration, to which the method of my invention is applicable.

Figs. 10 through 18 are schematic views illustrating in progressive stages the method of forming the gear of Fig. 9. Of these figures:

Fig. 10 is a perspective view of a stock or mass of material from which the gear is made.

Fig. 11 is an elevational view of such mass after it is given a preliminary shaping.

Fig. 12 is an elevational view of such mass after it is given a second preliminary shaping.

Fig. 13 illustrates a roughing impression made by a forging hammer.

Fig. 14 illustrates the final hammer forging impression.

Fig. 15 illustrates the blank in the apparatus employed for effecting formation of the blank for the smaller gear and the wide groove, just prior to the formation thereof.

Fig. 16 is a section taken in a plane indicated by line 6-6 in Fig. 15.

Fig. 17 illustrates the apparatus and the shape of the blank of Fig. 15, after formation of the blank for the smaller gear and the wide groove.

Fig. 18 illustrates the blank of Fig. 17 removed from the apparatus; the blank being shown in longitudinal section, and with the metal flow line formation on one side.

With reference to Fig. 1, the cluster gear is of integral construction and comprises hub 2 having large diameter gear 3 provided with teeth 4 on its peripheral or tooth face and smaller diameter gear 9 provided with teeth 7 on its tooth face. Between the gears is a comparatively narrow annular groove 6 which is adapted to receive a shifting fork. The inside of hub 2 is provided with splines 9 for mounting of the gear for rotatable movement with and axial movement along a transmission shaft. It is desirable that the gear be a steel forging for strength. Also, for a maximum strength, it is desirable that the metal flow lines resulting from the forging extend substantially radially adjacent each side of each cluster gear, as is indicated by the flow lines F in Fig. 8. This is so because maximum stresses are imparted to a gear in a radial direction, and radically extending flow lines enable the metal to withstand such forces.

The method of my invention produces such favorable flow line effect, and comprises utilizing a predetermined amount of a stock or mass of material to provide sufficient material for the formation of a single cluster gear, in contradistinction to the previously mentioned forging machine method wherein a long bar of stock is utilized for making a plurality of cluster gears therefrom. As is indicated in Fig. 2, the stock or mass of material 11 is preferably rectangularly shaped as this is more economical than round stock. However, round or any other suitably shaped stock may be employed if so desired. Such mass 11 is heated in any suitable manner to a suitable forging temperature, and is then preliminarily shaped by any suitable means, to elongate an end portion 12 and round the material as indicated in Fig. 3.

Next, a roughing impression is made by placing the blank of Fig. 3 in an upright position in die 13 which cooperates with vertically movable forging hammer 14 to form blank 16 for larger diameter gear 3, and shank portion 17. It is to be noted that pressure is applied to the material, by hammer 14, in an axial direction, and that die 13 and hammer 14 are so related as to provide forging parting line P intermediate the sides of blank 16 and transversely with respect to the peripheral or gear tooth face 18 of such blank. This is an important factor for causing the metal flow lines F for the larger diameter gear to extend radially adjacent each side of the gear, to provide for maximum strength.

After formation of the blank illustrated in Fig. 4, it is next hammer forged, by means similar to that illustrated in Fig. 4, to form a final hammer forging impression. Such final hammer forging impression is illustrated in Fig. 5, from which it can be seen that the contour of gear blank 16 and shank portion 17 are somewhat changed, but die 18 and vertically movable forging hammer 21, which provides pressure in axial direction, still cooperate to maintain parting line P at the desired location intermediate the sides of blank 16 and transversely with respect to gear tooth face 18 thereof. In the forging dies of Figs. 4 and 5, it is necessary to form so-called "draft" on the face 19 to enable the dies to be readily separated. After the shaping illustrated by Fig. 5, the "draft" is removed by any suitable means (not shown) to straighten face 19, as is illustrated by the vertical dotted lines in Fig. 5.

The blank of Fig. 5 after removal of the draft, is now ready for the formation of the smaller gear blank and the lap to which reference has been made.

For the latter purpose, such blank is placed in die 23 in which it fits closely and the upper edge 24 of which lies substantially flush with the upper side 26 of gear blank 16. An integral solid collar 27 is next properly centered loose about shank portion 17 to provide annular space 28 therebetween to allow for upsetting of material from shank portion 17; the collar 27 resting on top edge 24 of die 23 and on upper side 26 of the gear blank 16. As a result, when axial pressure is applied to shank 17, gear blank 16 will maintain substantially the same shape. The material adjacent gear blank 16 is next upset within collar 27, as is illustrated in Fig. 7, by application of pressure in an axial direction, which is preferably accomplished by vertically movable forging press member 29. This results in formation of smaller gear blank 31 for gear 6, and in the lap or fold 32. Such lap or fold 32 in the blank spacing to illustrate more clearly the invention but, in actuality, the faces of the lap are in substantial engagement.

Because the blank 16 for the gear of larger diameter is formed first, less material need be worked for forming the blank 31 for the gear of lesser diameter. This factor in association with collar 27, enables the location of lap 32 to be definitely controlled so as to form without, and not within the blank portion 16 for larger gear 3, as has heretofore occurred with respect to the
previously related forging machine method. As a result, when material is machined out to form groove 8, none of the material of blank 16 need be removed adjacent the hub portion, which if occurring would weaken the structure. Fig. 8 illustrates the blank after the shaping illustrated in Fig. 7, partially machined to provide groove 8, and wearing portion 45 which is subsequently punched out in any suitable manner. The forging cluster gear of Fig. 1 is made from the blank of Fig. 8 by usual machining operations.

From the preceding description, it is seen that the cluster gear of Fig. 1 is made essentially by first forming the blank for the larger gear by hammer forging in an axial direction, and then the smaller gear is made by upsetting through a pressing operation in an axial direction. These two steps also cooperate in association with the particular arrangement of the parting line P to provide flow lines F which extend substantially adjacent each side of each gear, to insure maximum strength.

Fig. 9 illustrates another form of cluster gear having a relatively wide groove 41 between large diameter gear 42 and smaller diameter gear 43. Because of the relatively large size of groove 41, it may be made during forging by means of an insert ring, without the necessity of forming a lap or fold of the material. This is so because the insert ring will have sufficient metal to enable it to withstand the forging temperature. However, the gear is otherwise made substantially the same as the gear of Fig. 1, to obtain the advantages resulting from such method.

As with respect to the method for making the gear of Fig. 1, the gear of Fig. 9 is preferably made from a predetermined amount of a stock or mass of material 44 which for economy is preferably, rectangularly shaped, but which may be any other suitable shape. Such stock or mass is heated, and preliminarily shaped in any suitable manner to round the corners thereof and elongate one end 45, as is illustrated in Fig. 11. Next, the bottom 47 is upset, in any suitable way, to shape the material in the manner illustrated in Fig. 12. A roughing impression 48 is then made by hammer forging, as is illustrated in Fig. 13, by means of bottom die 49 and upper vertically movable forging hammer 51, which results in the formation of blank 52 for large gear 42, in which parting line P is between the sides of the blank and transverse to the peripheral or tooth face 53 thereof.

Fig. 14 illustrates a final forging impression 54 which is next formed by hammer forging in lower die 55 cooperating with vertically movable hammer die 57; the forging parting line P in blank 52 remaining the same. After formation of the final impression 54, it is ready for formation of the blank for smaller gear 43, which is performed by a pressing operation in the manner illustrated in Figs. 15 through 17. However, before such pressing operation, the peripheral face 53 of gear blank 52 is first straightened in any suitable manner, to remove the draft, as is indicated by the dotted lines adjacent the sides thereof.

In the pressing operation a split die or collar comprising the two parts 59 having inner peripheral ring portion 61 is employed to form groove 41. The final hammer forging impression 54 is positioned on lower die 62; and split die parts 59 are also supported on lower die 62 with shank 63 passing loose through split die parts 59, as is illustrated in Figs. 15 and 16. A wedge 64 is provided between each die part 59 of the die and a fixed abutment 66. As a result, when forging press member 67 is moved downwardly to apply axial pressure, a metal of shank 63 is upset to form the blank 52 for smaller gear 43, as is illustrated in Fig. 17. During such operation, the shape of gear blank 52 remains substantially the same. Because of the split character of the die in which shank 63 is upset, it may be readily removed when the smaller gear blank 52 is formed; and the forging will then have the shape illustrated in Fig. 18, which is subsequently machined to provide the gear of Fig. 9.

The flow line P characteristics of the forging of Fig. 18 are also favorable by virtue of the described procedure, inasmuch as the flow lines extend substantially radially adjacent each side of each gear to impart strength to the peripheral or tooth face thereof. This is particularly so with respect to the flow line effect at point A, namely the lower peripheral edge of the smaller gear 43, because of the upsetting of shank portion 63 over inner peripheral ring 61. The employment of inner peripheral ring 61 to form groove 41, is also advantageous because of the saving of metal inasmuch as less material is required in the original stock.

Although the method of my invention is particularly applicable to the manufacture of an integral structure comprising a hub and a plurality of adjacent gears, it will be apparent from the preceding description that it is equally applicable to any similar article having only one gear and another radially projecting member spaced therefrom, or a hub having spaced radially projecting members.

I claim:

1. The method of making an integral cluster structure having a plurality of closely adjacent members integral with a hub, which comprises forging from a mass of material a blank for one of said members while providing a forging parting line which extends transversely with respect to the peripheral face of said blank and intermediate the sides thereof, and then forming another blank for another of said closely adjacent but spaced from said first mentioned blank and simultaneously folding material between said blanks upon itself and thereby forming a lap adjacent said first mentioned blank spaced from said first mentioned blank toward said other blank; the procedure for folding said material and forming said other blank and said lap comprising applying pressure on said mass forming said other blank axially toward said first mentioned blank while providing limited fold-forming freedom for the material between said blank and confining the material to form said other blank.

2. As an article of manufacture, a forged integral cluster gear having a plurality of gears integral with a hub and a groove therebetween, one of said gears being characterized by formation of a forging parting line extending transversely with respect to its tooth face and intermediate the sides of such gear.

3. As an article of manufacture, a forged integral gear blank structure having a hub, a gear blank integral with said hub, another blank member integral with said hub, and a lap located without said gear blank; said gear blank having radially extending flow lines adjacent each side thereof to provide strength for the gear tooth face of said blank, and a forging parting line
extending transversely with respect to said face and intermediate the sides of said gear blank.

4. As an article of manufacture, a forged integral cluster gear having a plurality of different size gears integral with a hub and a groove therebetween, a larger of said gears having radially extending flow lines adjacent each side thereof to provide strength for the tooth face thereof characterized by formation of a forging parting line extending transversely with respect to said face and intermediate the sides of said gear, and an adjacent smaller gear also having radially extending flow lines adjacent each side thereof.

5. As an article of manufacture, a forged integral metal blank cluster structure having a hub, a plurality of closely adjacent different size blank members extending radially from said hub, and a lap located without the larger of said blank members; each of said blank members having radially extending flow lines adjacent each side thereof to provide strength, and the larger of said blank members having a forging parting line extending transversely with respect to its peripheral face and intermediate its sides.

6. The method of making an integral cluster structure having a plurality of closely adjacent members integral with a hub, which comprises forging from a mass of material a blank for one of said members while providing a forging parting line which extends transversely with respect to the peripheral face of said blank and intermediate the sides thereof, then forming another blank for another of said members closely adjacent but spaced from said first mentioned blank and simultaneously folding material between said blanks upon itself and thereby forming a lap adjacent said first mentioned blank spaced from said first mentioned blank toward said other blank; the procedure for folding said material and forming said other blank and said lap comprising applying pressure on said mass forming said other blank axially toward said first mentioned blank while providing limited fold-forming freedom for the material between said blanks, and confining the material to form said other blank, and then removing the material adjacent said lap.

MARK A. AMMON.
CERTIFICATE OF CORRECTION.


MARK A. AMMON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, lines 43 and 44, strike out the words "lap and the blank for the larger gear after formation of the"; page 3, second column, line 63, claim 2, for "cen" read --one--; page 4, first column, line 11, claim 4, for "intermediate" read --intermediate--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of May, A. D. 1944.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.