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1,929,802

METHOD OF FORGING CYLINDERS FOR AIRPLANE MOTORS

Filed July 3, 1929

3 Sheets-Sheet 1

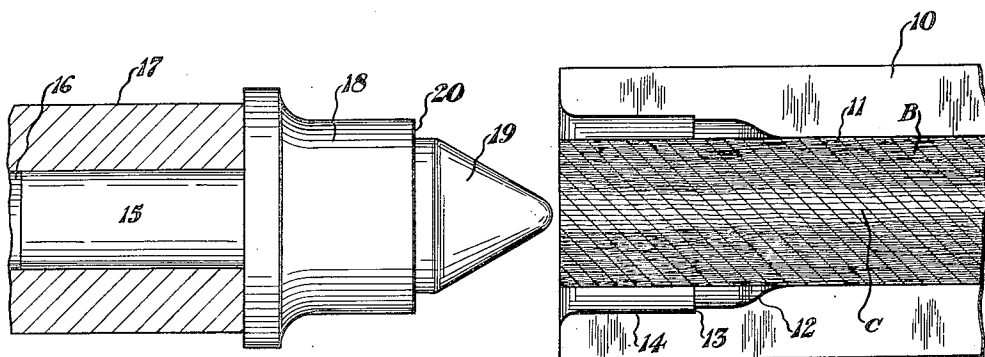


Fig. 1

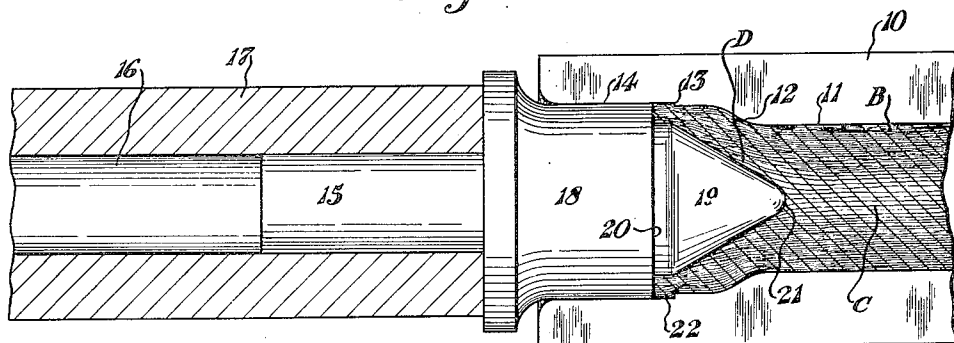


Fig. 2

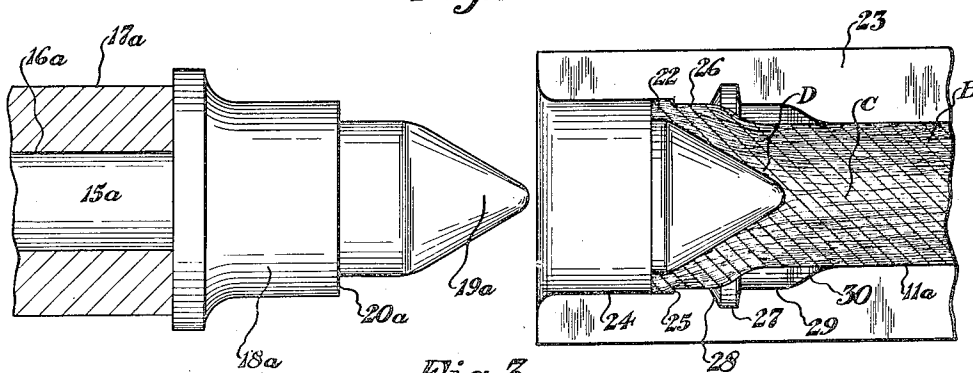


Fig. 3

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3 Sheets-Sheet 2

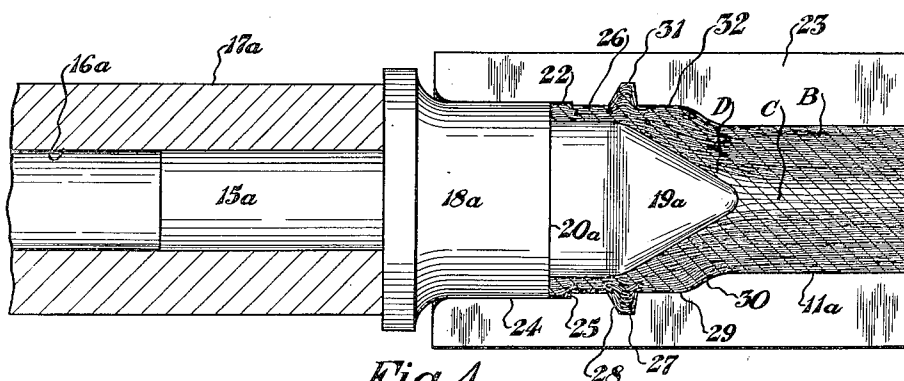


Fig. 4

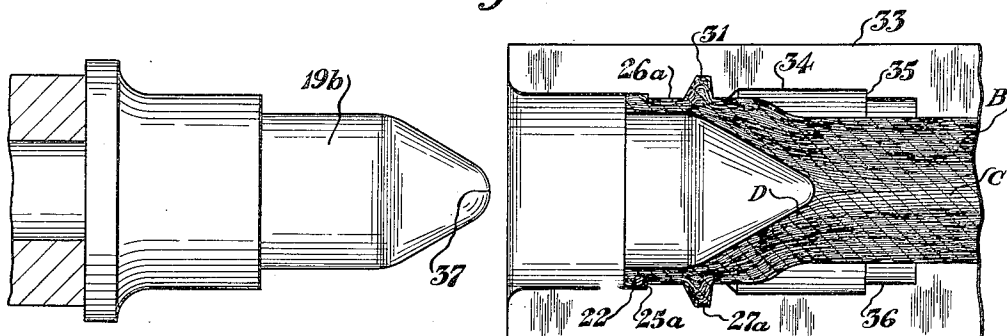


Fig. 5

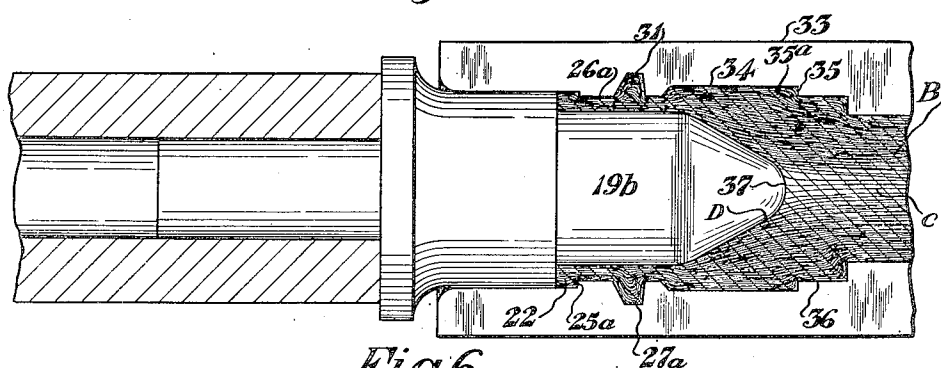


Fig. 6

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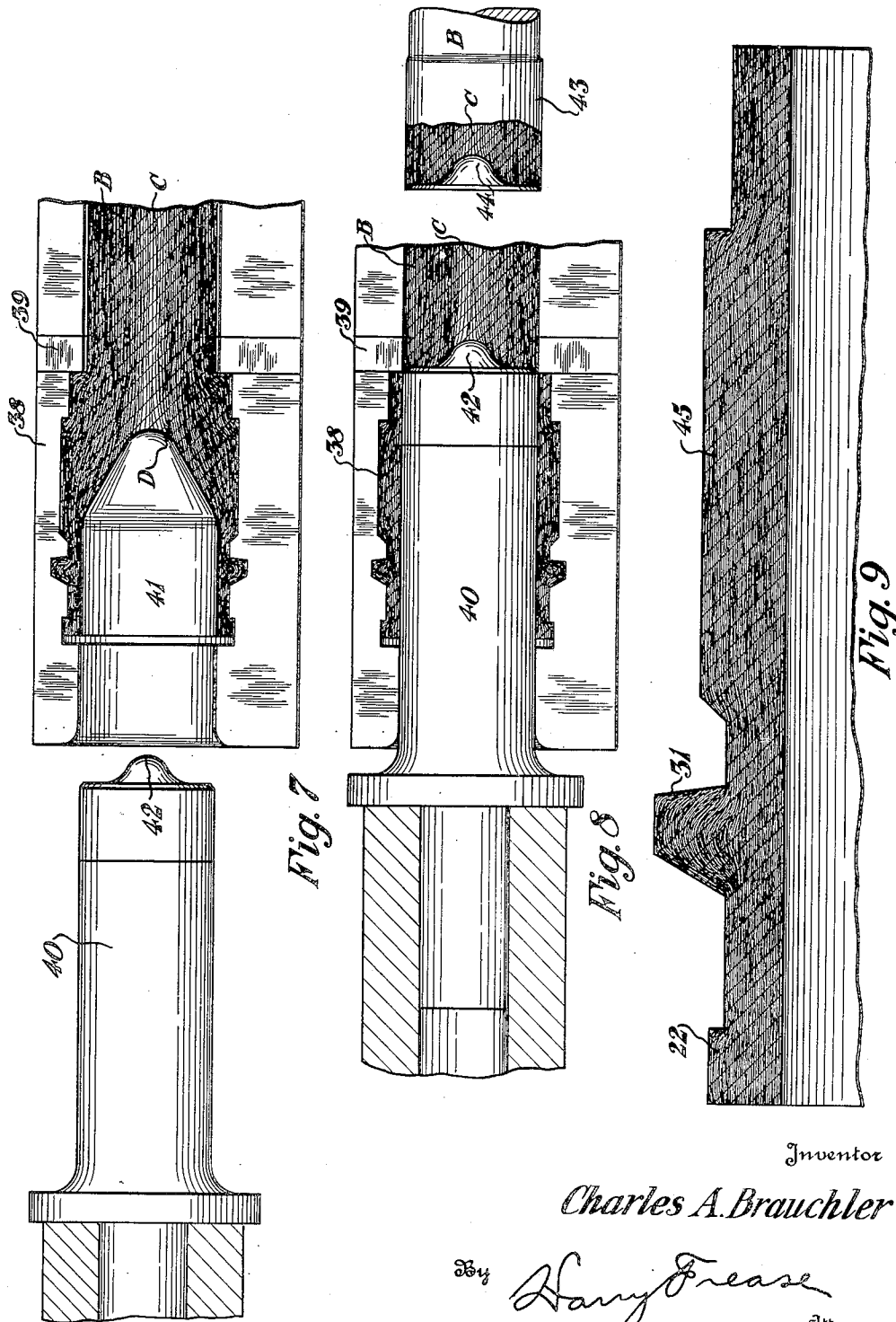
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METHOD OF FORGING CYLINDERS FOR AIRPLANE MOTORS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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METHOD OF FORGING CYLINDERS FOR
AIRPLANE MOTORS

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Application July 3, 1929. Serial No. 375,740

6 Claims. (29—156.4)

The invention relates to the forging of cylinders such as are used in air cooled motors for airplanes and the like, and more particularly to an upsetting method whereby the heated end of a bar, or a bar blank is pierced and spread to the desired size and shape.

It is common practice in forging such cylinders to place a heated blank, of the diameter desired in the finished article, in a die, and then by means of a plunger, of substantially the inside diameter of the finished article, a portion of the metal in the blank is displaced and extruded between the plunger and the inner walls of the die.

The blank is forged with this plunger until the required amount of metal is extruded, after which the solid end of the partially complete product is cut off, or punched off.

It will be seen that by this operation, the portion of the metal which is cut off, is worked into a much better condition than the extruded metal which forms the side walls of the cylinder.

The object of the present improvement is to provide a method of forging cylinders for air cooled airplane motors and the like, in which all of the grains of the metal in the side walls of the cylinder are under compression, and in which a substantially straight or longitudinal grain flow is produced, the grain following the outer contour of the forging, whereby a minimum of the fibers of the grain is cut by the necessary machining to complete the cylinder.

The above and other objects may be attained by a series of upsetting operations in which the end of a heated bar, or a heated bar blank is placed in a die and pierced by a plunger, displacing the metal from the center outward, compressing the displaced metal between the plunger and the die and adding to the strength and quality of the forging.

The improved method may be carried out as illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view through a die showing a bar therein and the plunger in position to form the first operation;

Fig. 2, a similar view, showing the first upsetting or piercing operation;

Fig. 3, a view of the die in which the second operation is formed, showing the partially complete product, as produced in the first operation, in position in the die with the plunger in position to form the second operation;

Fig. 4, a similar view showing the second upsetting operation;

Fig. 5, a view showing the product as produced in the second operation positioned in the die in which the third operation is performed;

Fig. 6, a similar view showing the third operation of the method;

Fig. 7, a view of the die and plunger with which the final forging operation is performed;

Fig. 8, a similar view showing the plunger in the operative position within the die, and showing the slug which is removed from the end of the forging or the end of the bar; and

Fig. 9, an enlarged sectional view through one side wall of the forging, showing the grain flow produced therein by the improved forging method.

Similar numerals refer to similar parts throughout the drawings.

The improved method of producing a forging for the purpose specified, by upsetting and piercing the metal, is carried out in a series of steps or operations, the heated bar blank being moved from one die impression to another after each operation, plungers cooperating with the dies to gradually pierce the heated bar blank and displace the metal outward into the dies, each operation increasing the piercing and displacement of the metal, and the final operation entirely piercing the forging from end to end.

In carrying out the invention, the first operation may be performed in a die impression illustrated generally at 10 in Figs. 1 and 2, and having the central opening 11 of a size and shape to receive the bar blank B.

The opening 11 is flared toward the outer end of the die, as shown at 12, and then shouldered at 13. The outer end portion of the opening, beyond the shoulder 13, is of slightly larger diameter, as shown at 14.

The plunger which cooperates with the die may be provided with a stem or shank 15, adapted to fit within the socket 16 of a reciprocating ram or the like, shown at 17. This plunger has the cylindric portion 18 of substantially the diameter of the enlarged opening 14 in the die impression, and adapted to be received therein, as shown in Fig. 2.

A reduced, substantially conical, piercing point 19 is formed upon the end of the cylindric portion 18 of the plunger, a peripheral shoulder 20 being provided around the same.

In performing the first step or operation of the improved method, the heated bar blank B is placed within the die impression 10, in the position shown in Fig. 1, and the plunger is moved

into the position shown in Fig. 2, the piercing point 19 piercing the outer end portion of the bar or blank, as shown at 21, and displacing the metal outward from the center, filing the die as shown in Fig. 2, and forming the peripheral shouldered portion 22 upon the outer end of the bar blank.

The plunger is then withdrawn and the partly completed product thus formed in the first operation is removed from the die impression 10 and placed in a die impression 23, shown in Figs. 3 and 4.

This die impression has the enlarged cylindric opening 24 at its forward or outer end to receive the shouldered portion 22 of the forging, being shouldered as at 25 and slightly reduced as at 26, conforming to the end portion of the forging.

A peripheral recess 27, tapered on one side as at 28, is formed in the die impression, spaced from the shoulder 25, a cylindric opening 29 being formed in the die impression beyond this recess and tapered as at 30 toward the central opening 11a, which receives the bar B.

In carrying out the second step of the improved method, the partly completed product is removed from the die impression 10 and placed in the die impression 23, as illustrated in Fig. 3. A second plunger cooperates with this die impression and may be provided with the reduced shank 15a, to be received in the socket 16a of a ram 17a.

This plunger is provided with the cylindric portion 18a adapted to be received within the enlarged cylindric opening 24 of the die impression, and is shouldered as at 20a and provided with the piercing point 19a of greater length than the point 19.

This plunger is then moved into the position shown in Fig. 4, further piercing and displacing the metal, as shown in said figure, the peripheral shouldered portion 22 abutting the shoulder 25 to hold the partly completed product against longitudinal movement in the die, and the plunger forcing the metal into the contour of the die impression, producing the peripheral flange 31 or shoulder and the enlarged cylindric portion 32 beyond the same. During this step the shouldered portion 22 is restricted against any outward expansion by the walls of the opening 22.

The product thus formed is then removed from the die impression 23 and placed in a die impression 33, shown in Figs. 5 and 6. This die impression has the shouldered portion 25a and a spaced peripheral recess 27a to receive the shouldered end 22 and peripheral flange 31 of the forging.

Spaced from the peripheral recess 27a, the die impression is provided with an enlarged cylindric opening 34 shouldered as at 35 and reduced as at 36 to substantially the diameter of the forward end portion 26a.

In performing this step, a plunger, similar to the plungers above described, but provided with a longer piercing point 19b, which preferably has a blunt end 37, cooperates with the die impression, as shown in Fig. 6, to further pierce the forging and displace the metal into the contour of the die impression, forming the shouldered portion 35a, the shouldered portion 22 abutting shoulder 25a of the die and the flange or shoulder 31 abutting the walls of the recess 27a to hold the partly completed product against longitudinal movement in the die.

The product as produced in the third operation is then placed within the die impression 38, illustrated in Figs. 7 and 8. This die impression has the same internal contour as the die impression 33, so that the forging substantially fits therein as shown in Fig. 7.

A shearing die 39 is located at the inner end of this die impression, and is of slightly greater diameter than the bar B, from which the forging is formed.

The plunger 40, which cooperates with this die impression, is substantially cylindric, of a diameter substantially that of the opening 41, which has been formed within the forging, and of a length sufficient to pass entirely through the forging. This plunger is provided at its end with the comparatively small piercing point 42.

As shown in Fig. 8, the plunger 40 pierces the forging entirely through from end to end, shearing the same from the bar B, by cooperation with the shearing die 39. During this piercing operation, the shouldered portion 22, the flange 31, and the shouldered portion 35a each abut corresponding shoulders upon the die to hold the partly completed product against longitudinal movement in the die.

The bar is forced through the shearing die by the action of the plunger, the end of the bar, which has been sheared from the forging, being slightly larger in diameter, as shown at 43, and having the socket 44 in its end produced by the piercing point of the plunger. This bar is again reheated and the operation is continued as above described to form another forging.

It will be seen that as with each successive step the forging is pierced to a greater depth and the metal is successively displaced outward from the center toward the outside, compressing the metal between the plunger and the die. Thus, the shouldered portion 22 is restricted against any outward expansion during the piercing operation next succeeding the one in which the shoulder was formed, and also during all subsequent piercing operations. Likewise each shouldered portion progressively formed upon the forging is restricted by the walls of the die against any outward expansion during all piercing operations subsequent to the one in which said shoulder was formed.

It is well known that the working received by steel in rolling produces a refinement of the grain near the surface in excess of that near the center. Therefore the bar blank from which the forging is made has a finer grain near the surface.

The coarser grain C toward the center of the bar is spread and compressed by the upsetting and piercing operations above described, as the metal is displaced from the center outward, as shown at D.

Thus it will be seen that this coarser grain forms only a very thin lamination upon the interior of the finished forging, and the greater part of this coarse grain will be cut away by the necessary machining upon the interior of the cylinder.

The best portion of the metal of the bar is thus put into the walls of the cylinder which are made up not only of the finer grained exterior of the bar, but of such of the inner portion of the bar as has been additionally worked by the compressing operation of the plungers.

The grain flow produced by this method of forging is illustrated in Fig. 9, showing an enlarged longitudinal section through the cylinder

forging, there being a substantially straight grain flow from end to end of the forging, the fibers of the grain toward the exterior following the outer contour of the forging.

5 With this arrangement of grain flow, it will be seen that when the necessary machine work is done upon the forging, there will be a minimum cutting of fibers of the grain thus producing a maximum of strength in the finished cylinder.

10 The peripheral flange 31 is formed upon the cylinder to provide for bolting the same in place upon the motor, and the enlarged cylindric portion 45 is provided for the formation of the usual air cooling fins.

15 Very little machine work is required upon the exterior of the cylinder to complete the same, and the only place where the fibers of the grain will be cut, is in the formation of these fins, and this is immaterial, since there is no strain imposed upon the same in the operation of the motor.

I claim:—

1. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, the first piercing operation forming a shouldered portion on the end of the bar for holding it against longitudinal movement during the next succeeding operation, said shouldered portion being restricted against any outward expansion during the next succeeding operation.

2. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, the first piercing operation forming a shouldered portion on the end of the bar for holding it against longitudinal movement during the subsequent piercing operations, said shouldered portion being restricted against any outward expansion during the subsequent piercing operations.

3. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, each

piercing operation except the last one forming a shouldered portion on the bar for holding it against longitudinal movement during the next succeeding piercing operation, and each shouldered portion being restricted against any outward expansion during the piercing operation next succeeding the one forming said shouldered portion.

4. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, each piercing operation except the last one forming a shouldered portion on the bar for holding it against longitudinal movement during the subsequent piercing operations, and each shouldered portion being restricted against any outward expansion during all piercing operations subsequent to the one forming said shouldered portion.

5. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, each piercing operation except the last one forming a shouldered portion on the bar for holding it against longitudinal movement during the next succeeding piercing operation, each shouldered portion being restricted against any outward expansion during the piercing operation next succeeding the one forming said shouldered portion, and the last piercing operation including shearing the pierced portion from the bar.

6. The method of forging cylinders which consists in heating a bar, and piercing the bar longitudinally by a series of progressive operations to displace the metal thereof outwardly, each piercing operation except the last one forming a shouldered portion on the bar for holding it against longitudinal movement during the subsequent piercing operations, each shouldered portion being restricted against any outward expansion during all piercing operations subsequent to the one forming said shouldered portion, and the last piercing operation including shearing the pierced portion from the bar.

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