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METHOD OF FORGING WITH THIN WEBS

Filed Oct. 11, 1955

Fig. 1

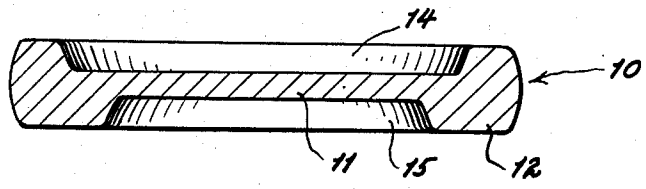


Fig. 2

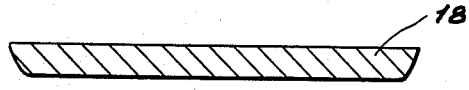


Fig. 3

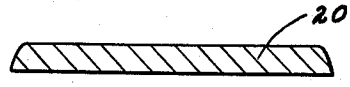


Fig. 4

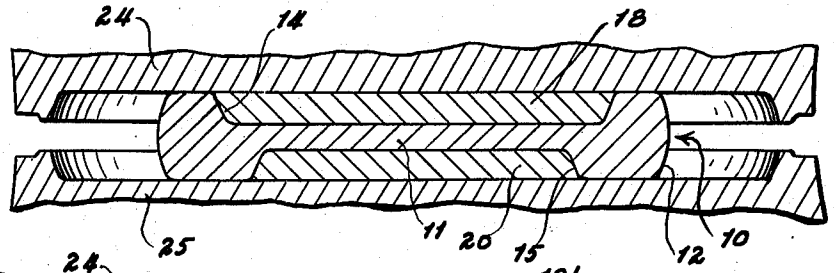


Fig. 5

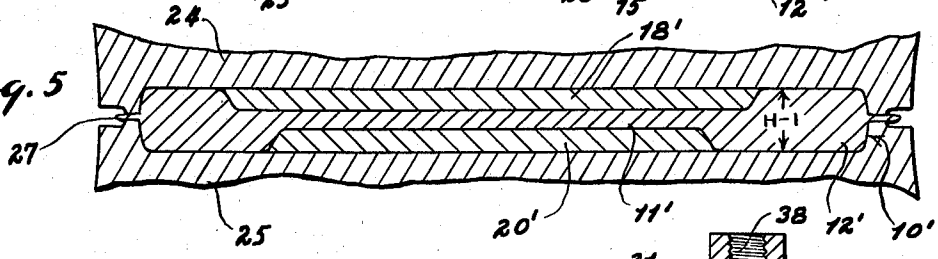


Fig. 6

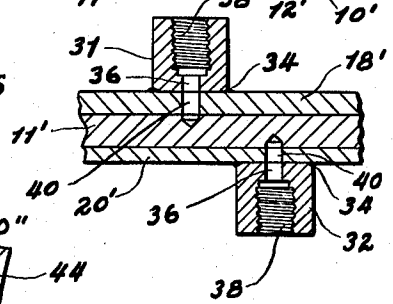
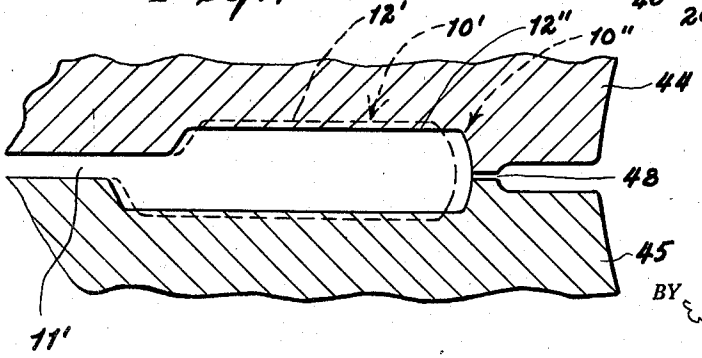


Fig. 7



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METHOD OF FORGING WITH THIN WEBS

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6 Claims. (Cl. 29—423)

This invention relates to the manufacture of metal discs having relatively thin webs and heavier rim sections.

It is difficult to forge metal parts, of the character indicated, when any great increase in diameter and reduction in thickness are required in the forging operation. This results from the excessive friction which is generated between the surfaces of the press or hammer and the flat faces of the work piece, especially the web. With materials that are highly resistant to deformation, even when heated to forging temperatures, the limitations become even more severe. Examples of such materials are titanium alloys, neimonic steels, S 816, and various stainless steels.

It is an object of this invention to provide an improved method for forging metal blanks which have webs and rim sections, and it is a more particular object of the invention to provide a method by which such blanks can be forged to larger diameters and thinner webs by a forging operation. The invention is intended for use with metal blanks of material which is highly resistant to deformation at forging temperatures, but it can be used with other materials in order to reduce the amount of force required for forging them.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views,

Figure 1 is a sectional view through a metal blank which is to be forged by the process of this invention;

Figures 2 and 3 are sectional views through pieces of filler that are placed against the web of the blank shown in Figure 1 during the forging operation;

Figure 4 is a sectional view showing the elements of Figures 1, 2 and 3 assembled in a sandwich and located between the dies of a forging press;

Figure 5 is a view similar to Figure 4 but illustrating the condition of the parts after the forging die has closed and reshaped the work piece;

Figure 6 is a fragmentary view illustrating one way in which the pieces of filler are removed from the web of the work piece after the forging operation illustrated in Figure 5; and

Figure 7 is an enlarged, fragmentary view showing a subsequent operation on the rim of the work piece.

Figure 1 shows a forging **10** having a web **11** and a heavier rim section **12**. In the construction illustrated, the web **11** is located intermediate the top and bottom surfaces of the forging so that there is a recess **14** above the web and another recess **15** below the web. The forging **10** may be made of a metal which is highly resistant to deformation, even at forging temperatures, as previously explained; and with such a forging it would be difficult or impossible to increase the diameter and reduce the thickness of the web **11** to any great extent by further forging steps.

In order to shape the forging **10**, in accordance with the method of this invention, a piece of filler **18** (Figure 2) is made to fit the recess **14**. Similarly, another piece of filler **20** is made to fit the recess **15**. These pieces of filler **18** and **20** are made of different material from the forging **10**; and they are made of material which is more easily deformed at forging temperatures. The actual material used for the pieces of filler **18** and **20** depends upon the temperature at which the forging operation is to be carried out, and this in turn depends upon the material of which the forging **10** is made.

If the forging **10** is a material which should be forged at a comparatively low temperature, for example 1930° F., then the pieces of filler **18** and **20** may be made of grey iron. If the forging operation is to be carried out at a temperature between 2000° and 2300° F., and the pieces of filler **18** and **20** may be made of mild steel. It is desirable that the pieces **18** and **20** should be sufficiently close to their melting points so that they are soft at the forging temperature.

Before being placed in a forging apparatus, the forging **10** and the pieces **18** and **20** are heated to the appropriate temperature for a further forging operation on the forging **10**.

Figure 4 shows the pieces **18** and **20** located in the recesses **14** and **15**, respectively, so as to form a sandwich with the forging **10**. Since the pieces **18** and **20** fit the recesses, the outer surfaces of these pieces **18** and **20** are flush with the faces of the rim **12**. In order to prevent seizing and galling, a coating of graphite, or other release material, may be placed between the confronting faces of the forging **10** and the pieces **18** and **20**.

When the pieces **18** and **20** are placed in the recesses in the forging **10**, they may be held in place by spot welding. This permits the sandwich to be handled without danger of having the pieces **18** and **20** fall out of the recesses, but it is not necessary in order to keep them in position after the sandwich has been placed in a press or forming die and it is not necessary for the forging operation of this invention.

Figure 4 shows an upper die element **24** and a lower die element **25** which are part of a forging apparatus. The die elements **24** and **25** have recessed faces which form a cavity having substantially the intended dimensions of the sandwich after the forging operation. These die elements **24** and **25** apply force simultaneously to the entire top and bottom surfaces of the sandwich. With this procedure, displacement of the pieces **18** and **20**, or any portion of them, from the recesses **14** and **15** is not a problem, even though the material of which these pieces are constructed has become very soft by being heated to the forging temperature.

The die elements **24** and **25** are brought together by means of steady pressure, or hammer blows, depending upon the particular forging apparatus; and in coming together into the positions shown in Figure 5, these die elements **24** and **25** distort the forging **10** into a work piece **10'** which has a thinner rim **12'** and a thinner web **11'**. The pieces of filler **18** and **20** are reduced in thickness to form pieces of filler **18'** and **20'**, respectively. Thus, corresponding parts of the forged sandwich in Figure 5 are indicated by the same reference characters as in Figure 4, but with a prime appended.

In the preferred forging operation of this invention, a flash **27** is formed around the outside of the rim **12'**, but this is not an essential feature of the invention. Such a flash, when produced, can be removed in any conventional way.

The forging operation represented by the movement of the die elements **24** and **25**, from the positions shown in Figure 4 to those shown in Figure 5, reduces the thick-

ness of the rim 12 and web 11 of the forging 10 and increases the diameter to the final, or substantially final, desired dimensions.

If the desired increase in diameter and reduction in web thickness exceeds that possible with this invention, further diameter increase and thickness decrease can be obtained by rolling and cross rolling of the sandwich after it is taken from the forging apparatus in the condition shown in Figure 5, as disclosed in patent application, Serial No. 448,460, filed August 9, 1954, now abandoned.

After the forging operation, it is necessary to remove the pieces of filler 18' and 20'. This can be done in various ways, one of which is illustrated in Figure 6. This view shows bosses 31 and 32 attached to the pieces 18' and 20', respectively, by welding 34. There are holes 36 extending through the bosses 31 and 32. These holes have counterbores in their upper portions and the counterbores contain threads 38 by which fittings can be connected to the bosses 31 and 32.

A drill is placed in the hole 36 of the boss 31, to drill and opening 40 through the piece 18' at least as far as the inner face of this piece 18'. A drill placed in the hole 36 of the boss 32 drills a similar opening 40 through the piece 20'. Fluid pressure, preferably liquid pressure, is then applied through the bosses 31 and 32. By using sufficiently high-pressure fluid, the pieces 18' and 20' are "exploded" from the web 11'.

Figure 7 shows a subsequent forging step which is used in order to obtain greater dimensional accuracy of the rim, particularly of the internal rim shape. When this step is to be used, the die elements 24 and 25, shown in Figures 4 and 5, are constructed so as to leave the rim 12' with a thickness H–1 slightly greater than the intended thickness of the final rim. The work piece 10' is then placed between other die elements 44 and 45 for further forging of the rim 12'. As the die elements 44 and 45 come together, the rim 12' is deformed to the dimensions of the closed die, and this final rim is indicated by the reference character 12''. The final work piece is indicated by the reference character 10''.

The die elements 44 and 45 are preferably constructed so that their faces which confront the web 11' do not contact with the web until the die elements have shaped the rim 12'' to its final dimensions. Thus, contact of the die elements 44 and 45 with the web 11' serves as a limit stop for the forging apparatus when performing the operation illustrated in Figure 7. This leaves a clearance 48 between the die elements 44 and 45 when the forging operation of Figure 7 is completed. Any flash extruded into this clearance 48 is subsequently removed in the conventional manner.

The invention has been described in connection with circular work pieces for which it is primarily intended. It will be understood, however, that the work piece can have other shapes. When used for rectangular panels, or panels of any other non-circular shapes, the original forging may be designed with any distortions which are necessary to compensate for uneven flow of the material in such cases.

The drawing shows the filler pieces located above and below the forging, but it will be understood that the original disc or forging 10 can be reshaped, in accordance with this invention with the axis of the disc horizontal instead of vertical, or with the sandwich in any desired orientation. Terms of orientation in the description and claims are, therefore, relative.

The perferred embodiment of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. The method of forging a circular work piece made of metal, having forging temperature at least as high as titanium alloys, and in which the work piece has a web surrounded by a circumferential rim section of greater thickness than the web and the work piece is to be forged into a circular piece of larger diameter and with a thinner rim and web than the original work piece, which method comprises increasing the diameter and reducing the thickness of both the rim and web of the original work piece by placing solid but malleable filler metal, of lower forging temperature than that of the work piece, against the web of the work piece to a level substantially flush with the top side of the rim and within the inner radial limits of the side of the rim to reduce the friction of the work piece and a forging die element, heating the work piece and filler metal to a normal forging temperature of the work piece, and with the work piece and filler metal thus heated, reducing the rim and web to substantially the desired thickness by applying high and deforming forging pressure of a forging die element simultaneously to the top side of the rim and to the entire top side area of the filler metal, and by said pressure simultaneously reducing the thickness of the filler metal, web and rim with resulting increase in their diameters, areas and radial extents, whereby the surfaces of the filler metal in contact with the work piece flow with the surfaces of the work piece, and then removing the filler metal.

2. In the shaping of a metal disc between forging die elements and from an original work piece having a web surrounded by a circumferential rim section of greater thickness than the web, the improvement which comprises increasing the diameter and reducing the thickness of both the rim and web by placing solid but malleable filler material, of lower forging temperature than the work piece, against the web of the work piece to a level substantially flush with the top side of the rim and within the inner radial limits of the side of the rim to reduce the friction of the work piece and a forging die element, heating the disc and filler material to a forging temperature of the disc, and with the disc and filler material thus heated, reducing the rim and web to substantially the the desired thicknesses by applying high and deforming forging pressure of a forging die element simultaneously to the top side of the rim and to the entire top side area of the filler material, and by said pressure simultaneously reducing the thickness of the filler material, web and rim with resulting increase in their diameters, areas and radial extents, whereby the surfaces of the filler material in contact with the disc flow with the surfaces of the disc, and in which a coating of material is applied to the blank between the confronting surfaces of the blank and the filler material to prevent seizing and galling during the deformation of the blank under pressure.

3. In the shaping of a metal disc between forging die elements and from an original work piece having a web surrounded by a circumferential rim section of greater thickness than the web, the improvement which comprises increasing the diameter and reducing the thickness of both the rim and web by placing solid but malleable filler material, of lower forging temperature than the work piece, against the web of the work piece to a level substantially flush with the top side of the rim and within the inner radial limits of the side of the rim to reduce the friction of the work piece and a forging die element, heating the disc and filler material to a forging temperature of the disc, and with the disc and filler material thus heated, reducing the rim and web to substantially the desired thicknesses by applying high and deforming forging pressure of a forging die element simultaneously to the top side of the rim and to the entire top side area of the filler material, and by said pressure simultaneously reducing the thickness of the filler material, web and rim with resulting increase in their diameters, areas and radial extents, whereby the surfaces of the filler material in contact with the disc flow with the surfaces of the disc, and in which the filler is a metal different from that of the blank and one which is soft and malleable at

the forging temperature of the blank, and in which a coating of release material is applied to the surface of the blank which contacts with the filler material to prevent seizing and galling of the different metals.

4. In the shaping of a metal disc between forging die elements and from an original work piece having a web surrounded by a circumferential rim section of greater thickness than the web, the improvement which comprises increasing the diameter and reducing the thickness of both the rim and web by placing solid but malleable filler material, of lower forging temperature than the work piece, against the web of the work piece to a level substantially flush with the top side of the rim and within the inner radial limits of the side of the rim to reduce the friction of the work piece and a forging die element, heating the disc and filler material to a forging temperature of the discs, and with the disc and filler material thus heated, reducing the rim and web to substantially the desired thickness by applying high and deforming forging pressure of a forging die element simultaneously to the top side of the rim and to the entire top side area of the filler material, and by said pressure simultaneously reducing the thickness of the filler material, web and rim with resulting increase in their diameters, areas and radial extents, whereby the surfaces of the filler material in contact with the disc flow with the surfaces of the disc, and in which the web is distorted to its final intended thickness by the pressure applied simultaneously to the filler material and the rim, and after the filler material

is removed subjecting the rim to a further forging operation to bring it to accurate final dimensions without further reduction in the thickness of the web.

5. The method of shaping a metal disc, as described in claim 4 and in which the final sizing of the rim is performed between pressure elements which move toward one another to reduce the thickness of the rim, and the web is used as a limit stop for the pressure elements to determine when their spacing is equal to the intended final thickness of the rim.

6. The method of forging a work piece as described in claim 1, and in which the rim extends beyond the web on both sides of the web, and in which the filler material is placed on both sides of the web to a level substantially flush with the upper and lower sides of the rim respectively, and the forging pressure is applied simultaneously to the top and bottom sides of the rim and to the entire top and bottom areas of the respective filler material.

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