March 6, 1956 W. A. BARNES 2,736,948

FORGING APPARATUS

Filed July 3, 1950 2 Sheets-Sheet 1

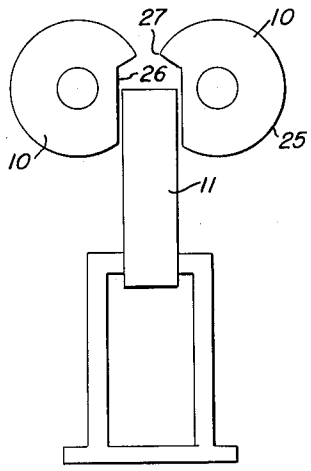


Fig. 1

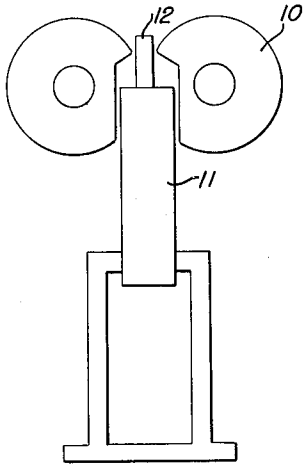


Fig. 2

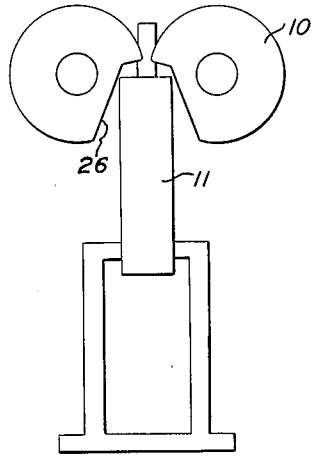


Fig. 3

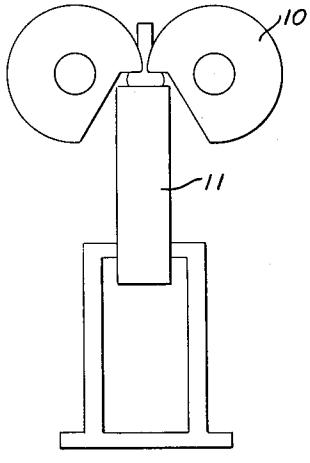


Fig. 4

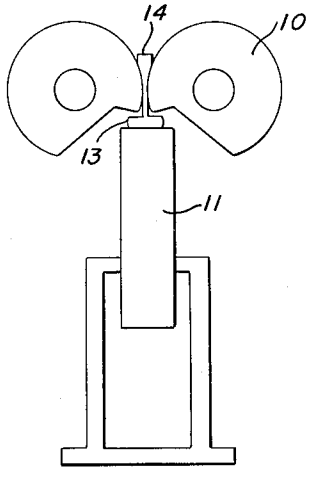


Fig. 5

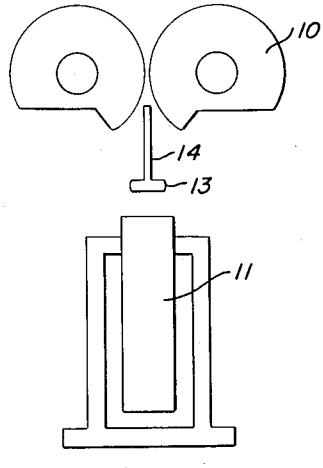


Fig. 6

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FORGING APPARATUS

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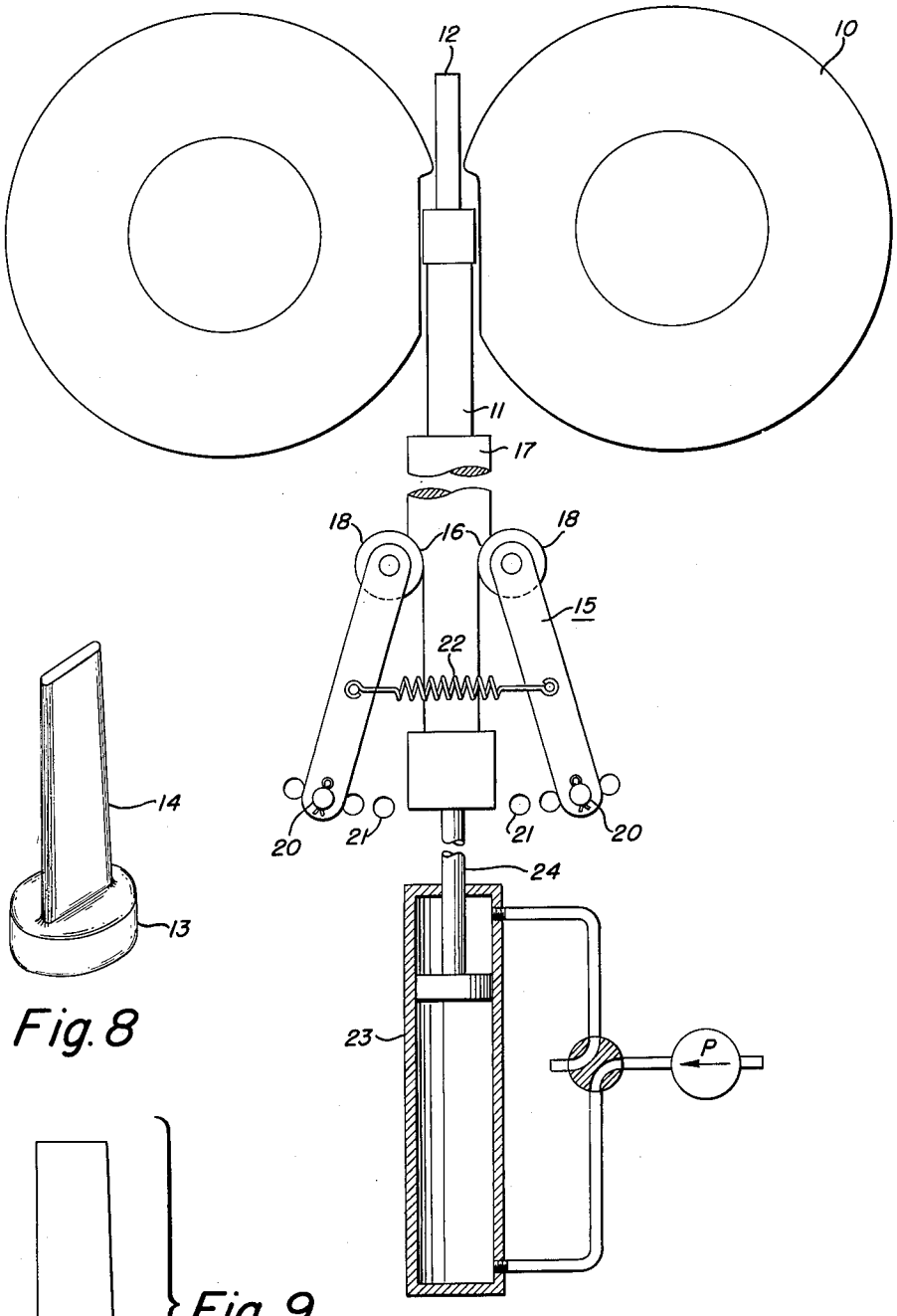


Fig. 7

Fig. 8

Fig. 9

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2,736,948

FORGING APPARATUS

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Application July 3, 1950, Serial No. 171,914

2 Claims. (Cl. 29—35)

This invention relates to forging practices in general, and relates more specifically to fields of upsetting and rolling.

The primary object of this invention is to perform two forging operations in one cycle of a forge machine.

Another object of this invention is to produce a workpiece from a work blank, wherein the workpiece has one end enlarged with respect to the work blank, and the other end reduced.

Another object of this invention is to produce such a workpiece in one operative work cycle of a forging machine.

Still another object of this invention is to produce a turbine, or similar type blade, in which the grain flow of the material between the blade and the base is substantially unbroken, thereby providing improved strength characteristics.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figures 1–6 illustrate progressive steps in one embodiment of a forging process incorporating the principles of this invention;

Figure 7 illustrates diagrammatically the operating parts of a machine embodying the principles of this invention;

Figure 8 is a perspective view of a forging made by the process and apparatus of this invention; and

Figure 9 is a side and bottom view of the finished blade made from the forging illustrated in Figure 8.

Machines having two cooperating rollers to form special surfaces are well-known in the metallurgical field. Likewise, roll forging may be carried out on a machine having one arcuate and one flat forging surface. The flat surface may be a moving surface, or a stationary surface. Such machines are available in particular styles, and have special cooperating features, according to the type of work which they are designed to do. However, all of these machines, regardless of their individual particular designs, operate on substantially the basic principle of having two cooperating surfaces, with at least one of said surfaces being curved. The surfaces produce a roll forge action upon a workpiece held between these rollers. In many of the machines the surfaces have a portion thereof recessed away in order that the surfaces will be in cooperative forging relationship only during a part of one complete revolution.

In the Figures 1 through 6 of the drawings, two rollers **10** are illustrated in their cooperating relationship. No machine structure is illustrated to support and drive the rollers **10**, because such machine structures are well-known in the industry and would serve no useful purpose in the drawings. Two rollers **10** are chosen as illustrative, not exhaustive, of the rolling forge action possible.

The rollers **10** each have an annular surface including a curved work portion **25** and a relief portion **26**. The

relief portion is simply a conveniently recessed notch in the annular surface of the roller to space the annular surfaces of the two rollers out of forging relationship. Such a relief portion **26** produces a shoulder area **27** between the work portion surface and the relief portion surface. Normally, one complete revolution of the rollers **10** is a full work cycle and completes the forging operation.

Many types of metal structures require a combination of large and small portions in one piece. An example of such a workpiece is a turbine blade for modern high-sped turbines and air compressors. Heretofore, any workpiece requiring an enlarged area was produced by upsetting. A blank of approximately the size of the smallest portion is heated and upset in a series of upsetting operations untill the small stock is enlarged at one end. The enlarged end may then be forged or machined to produce the enlarged portion of the workpiece. However, there are practical limits of upsetting beyond which useful forgings cannot be produced.

An alternative of upsetting is to start with a large piece of stock and reduce a portion of that large stock to the size of the small area of the workpiece. Such forging operations are not always possible, especially if a sharp shoulder is required between the large and small areas of the workpiece, such as in the turbine blade. Either extensive upsetting or extensive forging from large stock will be likely to disrupt the grain structure of the stock material and disrupt the strength of the finished piece.

According to this invention, an intermediate size stock piece is both enlarged by upsetting and reduced by roll-forging in one continuous process. The process is illustrated diagrammatically in the Figures 1 through 6. A machine is provided of suitable structure to support and rotate the rollers **10**. A workpiece positioned between the rollers **10**, as illustrated in Figure 2, lies in a path which may be called a work path. Rotation of the rollers **10** will cause the shoulders **27** to progress toward one another to indent or shoulder and grip the blank **12**. Continued rotation of the rollers **10** then will force the blank **12** to move along the work path. The rollers **10** will continue to rotate and forge the portion of the blank **12** rearwardly of the area at which the shoulders **27** make contact with the blank **12**. Therefore, to start the work cycle, the blank **12** can be extended along the work path beyond the shoulders **27** for a selected portion of its length, and the area beyond the shoulders **27** will not be forged by the rollers.

According to this invention, the roll-forging and upsetting process are carried out in one forging cycle. This process is highly saving of time, but other advantages are of even more importance. The finished forging is stronger with the grain structure thereof intact, and flowing evenly between the small and large portions of the forging. Less metal movement is required in cold forging, and heat damage reduced tremendously in hot forging.

This invention contemplates holding a workpiece between two parts of a roll-forge means. At least one of the two parts is arcuate for roll-forging. An upset forge means, or anvil, is mounted in position for contact of the workpiece upon relative movement of the roll-forge means and upset means. It has been found that this process can be successfully carried out in apparatus wherein the anvil is stationary, and the workpiece is moved by operation of the roll-forge means, or in apparatus in which the anvil moves, either before or at the end of the roll-forge operation.

One successful apparatus embodying the features of this invention is illustrated in the drawings. The usual roll-forging is altered in this structure by the provision of an anvil **11** lying in the work path to obstruct and/or prevent

free movement of the blank 12 leaving the rollers 10. In Figure 3 the blank 12 is seen to be enlarging on the end thereof against the anvil 11. The rollers 10 are rotating, and the workpiece blank 12 does not provide enough resistance to the rotation of the rollers 10, so therefore an upsetting operation takes place on that portion of the workpiece blank 12 which was extended beyond the shoulders 27. Suitable mechanism of any convenient type may be employed to hold the anvil 11 against release for a period of time sufficient to produce the desired amount of upsetting on the workpiece blank 12.

The Figures 1 through 4 illustrate the anvil 11 held against movement, and accordingly illustrate the increasing upset size of the workpiece blank 12. In Figure 5 the anvil 11 has been released and an upset or enlarged portion 13 has been completed. Upon the release of the anvil 11, the portion 13 can move away from the rollers 10 without further forging, but the portions of the workpiece blank 12 caught between the surfaces 25 are rolled during the remainder of the work cycle of the rollers 10 until a fully rolled blade portion 14 is produced. In Figure 6 the finished workpiece, having the upset portion 13 and the blade portion 14 completed, is illustrated dropping from the rollers 10.

During the experimental testing of this invention, several different methods of retarding the anvil 11 were devised, each having a certain degree of success. It was found that the anvil could be held absolutely fixed against movement for a period of the work cycle and then suddenly released, as illustrated in the Figures 1 through 6, or the anvil could be released gradually in a predetermined ratio with respect to the work cycle, thereby producing various effects upon a workpiece. In any event, it is believed that this is the first combination of roll-forging and upsetting, and the process has produced turbine blades and other similar types of forgings having improved strength characteristics and decreased machining costs heretofore unknown.

Among the successful types of mechanisms for retarding the movement of the anvil 11 is the retarder mechanism 15 illustrated in Figure 7 of the drawings. The mechanism 15 is of the type allowing sudden release for production of workpieces suitable for making high-speed turbine blades. The retarder mechanism 15 includes a shaft 17 to hold the anvil 11. The shaft 17 is provided with curved shoulders 16 thereon. Pivot arms 19 having wheels 18 thereon proportioned to fit the curved shoulder 16, are pivotally mounted on two sides of the shaft 17 and are urged to pivot toward one another by a strong spring 22. The arms 19 are pivoted upon a pivotal mounting 20. A plurality of pivot points are provided for the pivotal mounting 20. The pivot points are holes in the casting of the particular forge machine used for this development. Accordingly, the amount of force upon the shaft 17 required to cam the pivot arms 19 out of the cooperating shoulders 16 may be predetermined by a selection of the pivot point. Furthermore, the strength of the spring 22 may be varied to alter the pressure required to disengage the wheels 18 from the shoulders 16. It will readily be understood that the workpiece 12, when carried through the process illustrated in the Figures 1 through 6, will produce a considerable end thrust upon the anvil 11 which lies in the work path. The end thrust is transferred to the shaft 17. Resistance to the end thrust is provided by the pivot arms 19 in an amount determined by the location of the pivotal mounting 20 and the strength of the spring 22. When the end thrust is sufficient to cause the wheels 18 to ride up the shoulders 16, this disengagement will take place suddenly and allow the end thrust to force the anvil 11 and shaft 17 rapidly along the work path and out of interference with free movement of the workpiece blank 12.

An air cylinder 23 connected to the shaft 17 by a rod 24 is provided to return the shaft 17 and anvil 11 back into proper relationship with the rollers 10 for the next work cycle.

It is of course understood that the Figure 7 is diagrammatic only, and the actual machine parts to drive the rollers 10 and support the shaft 17 and the air cylinder 23 are not shown because these parts will be readily understood by those familiar with forging practice.

In Figure 9 of the drawings an actual turbine blade is illustrated. This blade is used for supplying air for jet propulsion.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. An apparatus for upsetting and rolling comprising a pair of oppositely disposed rolls each having work surfaces on their respective perimeters, support means for rotatively supporting said rolls, each said roll work surface including an arcuate rolling surface and an upsetting surface, said upsetting surface meeting said arcuate rolling surface to form a working edge and extending radially inwardly therefrom, an anvil having a support portion and a working surface, said working surface of said anvil extending between said oppositely disposed rolls and being located in a work position opposite said upsetting surface of said rolls for co-operation therewith, said support portion of said anvil comprising a load yieldable means holding said anvil working surface in said work position between said rolls whereby said anvil is retracted from said work position between said oppositely disposed rolls when a predetermined actuating force is exerted between said upsetting surfaces of said oppositely disposed rolls and said working surface of said anvil.

2. An apparatus for upsetting and rolling comprising a pair of oppositely disposed rolls each having work surfaces on their respective perimeters, roll support means for rotatively supporting said rolls, each said roll work surface including an arcuate rolling surface and an upsetting surface, said upsetting surface meeting said arcuate rolling surface to form a working edge and extending radially inwardly therefrom, an anvil having a working surface, said working surface of said anvil extending between said oppositely disposed rolls and being located in a work position opposite said upsetting surface of said rolls for cooperation therewith, load yieldable means for positioning said anvil and said roll support means relative to each other for holding said anvil working surface in said work position between said oppositely disposed rolls whereby said rolls and said anvil are retracted relative to each other from said work position between said oppositely disposed rolls when a predetermined actuating force is exerted between said upsetting surface of said oppositely disposed rolls and said working surface of said anvil.

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