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METHOD OF FLATTENING METALLIC DISCS

Filed June 28, 1962

Fig. 1

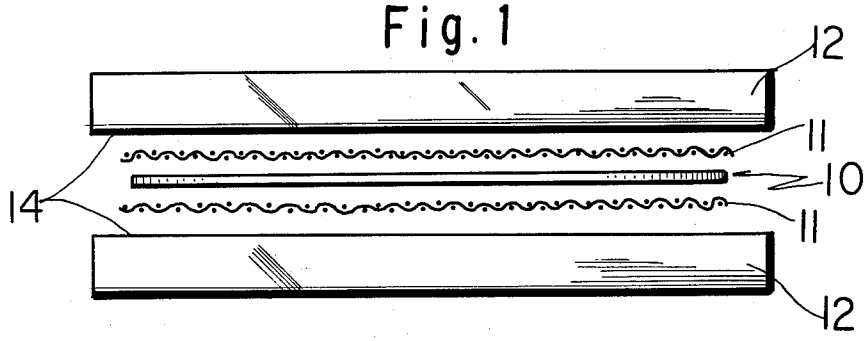
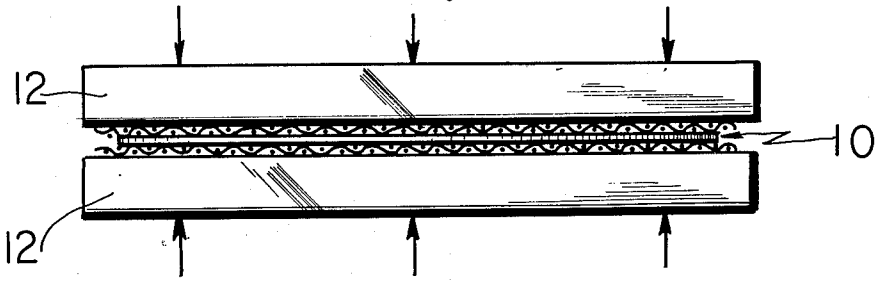


Fig. 2



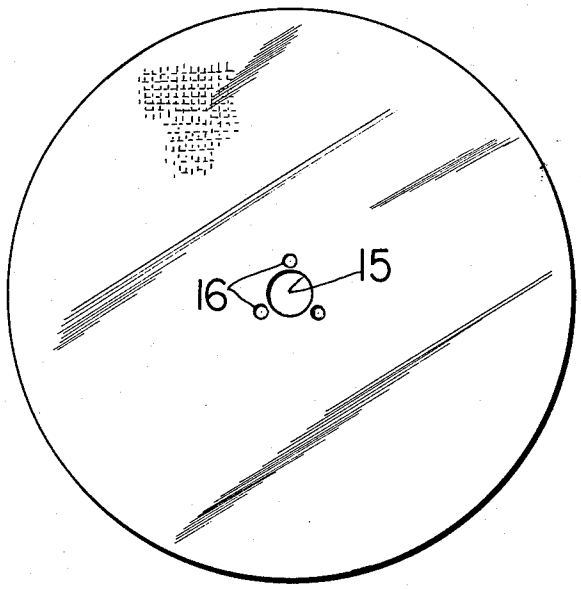


Fig. 3

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METHOD OF FLATTENING METALLIC DISCS

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3 Claims. (Cl. 72—376)

The present invention relates to metal working, and more particularly to shaping one piece blanks by deforming to flatten the same.

The present invention is concerned with, but not limited to, producing almost absolutely flat metallic discs adapted to be used as the rotor of a torque motor wherein the rotor is caused to rotate between a pair of closely spaced apart opposed induction coils. Since the efficiency of such a motor greatly decreases as the space between the coils increases, it is desirable that the rotor disc approaches absolute overall flatness so that the required clearance between the sides of the disc and the coil adjacent thereto can be reduced to a minimum without danger of mechanical contact between the disc and the coils due to deviations from flatness.

Accordingly, an object of the present invention is to provide an improved method of producing almost absolutely flat metallic disc.

Another object is to provide such a method which can be utilized to flatten discs of considerable area.

Another object is to provide such a method which is simple, practical, reliable and economical.

A further object is to provide such a method wherein the results are reproducible within narrow predetermined limits.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention, it has been discovered that the foregoing objects can be generally accomplished by sandwiching a relatively ductile metallic disc between a pair of metallic screen sheets having lesser ductility than the disc; placing the sandwich between a pair of dies having rigid, flat, parallel and relatively hard opposed surfaces; moving the surfaces into engagement with the screen sheets; and applying sufficient mechanical pressure on the dies to flatten the disc.

The metallic discs which are adapted to be so flattened can be constructed of relatively ductile metals or metallic alloys such as copper, aluminum or brass which have or can be annealed to a Rockwell B hardness of about 10 to about 20. Such discs thus may be considered relatively ductile or soft with reference to dies or plates formed of tool steel or the like having a Rockwell C hardness of about 40 to about 70. The screen sheets can be constructed of metals or metallic alloys, such as cold drawn steel or bronze wire, which are less ductile than the discs but are more ductile or soft than the dies or plates in the sense that such steel has a Rockwell C hardness of about 25 to about 50 and bronze has a Rockwell B hardness of about 60 to about 90. The dies or plates thus may be considered to have a relatively hard surface with reference to the discs and the screen sheets.

The mesh of the screen may vary with the area of the disc to be flattened, that is, a finer screen may be used for small discs and a coarser screen may be used for large discs. The mesh of the screen for example may range from about 8 to about 24. In practicing the present invention, it has been found that commercial or so called window screen having a 16 mesh (16 x 16 wires per inch)

and formed of wires of between about 0.01 and 0.02 inch in diameter may be employed with discs varying over a wide range of the areas.

The dies or plates have a sufficient thickness and strength to resist bending and have opposed surfaces ground flat and disposed parallel to each other. The pressure applied to the plates or dies is on the order of at least a hundred tons; and the pressure required to effect flattening of the discs varies in magnitude with area of the disc and the hardness of the disc material.

In the drawing:

FIG. 1 is an exploded elevational view illustrating the manner in which the disc and the screens are placed between the die plates.

FIG. 2 is a similar view illustrating the die plates applying pressure on the screens and the disc.

FIG. 3 is an elevational view of a motor disc which has been flattened in accordance with the present invention.

Referring now to the drawings in detail, there is shown in FIG. 1 a disc **10** sandwiched between a pair of screens **11** with the sandwich placed between a pair of dies or plates **12** having flat, parallel surface **14**.

As shown in FIG. 2, the dies **12** are brought together under mechanical pressure to cause the surfaces **14** to engage the screens **11** and to apply pressure on the disc **10** through the screens to induce cold flow and flatten the disc.

In so flattening the disc, it has been observed that if sufficient pressure is applied to make the disc almost absolutely flat, the mesh of the screen is impressed upon the side surfaces of the disc. However, such impressions do not adversely affect the overall flatness of the disc, and appear to stiffen the disc which is desirable when the disc is used as a rotor of a torque motor.

In FIG. 3, the disc is shown proivded with an aperture **15** at the center thereof for receiving a shaft (not shown) and with radially offset apertures **16** for receiving means for securing a hub or coupling (not shown) adapted for securement to the shaft. Preferably, these apertures are formed before the disc is flattened.

As a specific example of carrying out the method in accordance with the present invention a disc **10** of electrolytic tough pitch copper annealed to a hardness of about 20 Rockwell B and having a diameter of about 9 inches and a thickness of about 0.032 inch was sandwiched between a pair of 16 mesh steel wire screens **11** of about 30 Rockwell C hardness which completely covered the side surfaces of the disc. This sandwich was placed between tool steel dies having a hardness greater than the screen, and between about 300 and about 350 tons pressure were applied to the dies to transmit a pressure of between about 9700 and about 11,300 p.s.i. on the side surface of the disc. This method was carried out at room temperature without supplying heat or removing heat from the disc.

The flattened disc was placed on a test fixture and was rotated while measuring the flatness thereof. It was observed that on a circumference of about a 3.5 inch radius the disc had an overall flatness within 0.004 inch. Other discs were produced under identical conditions and were found to have substantially identical flatness.

It was also found that best results can be obtained by using new sheets of screen for each pressing.

The discs so produced were utilized as the rotor of a torque motor having the core of opposed coils spaced apart only about 0.060 inch. While a clearance of less than about 0.015 was provided between each side of the disc and the coil adjacent thereto, the rotor disc at no time made mechanical contact with the coils and was driven effectively at low power consumption because of the small air gap between the coils.

From the foregoing description, it will be seen that the present invention provides a novel and useful method of flattening discs.

The term disc is used herein in a broad sense and is intended to include plates which are not circular.

It will be understood that the details and examples hereinbefore set forth are illustrative only and that the inventioin as broadly described and claimed is in no way limited thereby.

I claim:

1. The method of flattening discs, which method comprises sandwiching a relatively ductile metallic disc between a pair of metallic screen sheets having lesser ductility than the disc; placing the sandwich between a pair of dies having rigid, flat, parallel and relatively hard opposed surfaces moving the surfaces into engagement with the screen sheets; and applying sufficient mechanical pressure on the dies to flatten the disc.

2. The method of flattening discs, which method comprises sandwiching an annealed copper disc between a pair of bronze or steel screen sheets; placing the sandwich between a pair of rigid tool steel plates having flat and parallel opposed surfaces; moving the surfaces into engagement with the screen sheets; and applying sufficient mechanical pressure on the plates to flatten the disc.

3. The method according to claim 2, wherein the disc has a thickness of about 0.032 inch and a diameter of about 9 inches, the screen sheets have a mesh of about 16, and between about 300 and about 350 tons pressure are applied to the plates, whereby the disc is provided with an overall flatness of within about 0.004 inch and has the mesh of the screen sheets impressed thereon.

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