July 15, 1969 J. H. MAKER 3,455,152

METHOD FOR QUICKLY DETERMINING HYDROGEN EMBRITTLEMENT OF METALLIC PARTS

Filed Jan. 5, 1967

Fig. 1

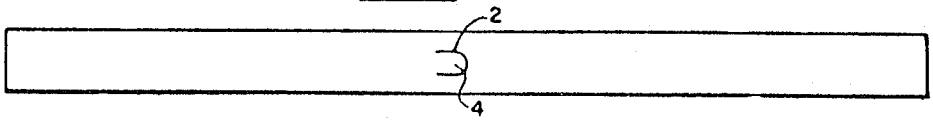


Fig. 2

Fig. 3

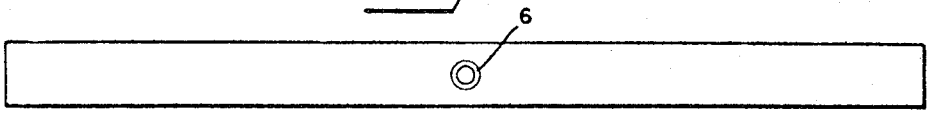
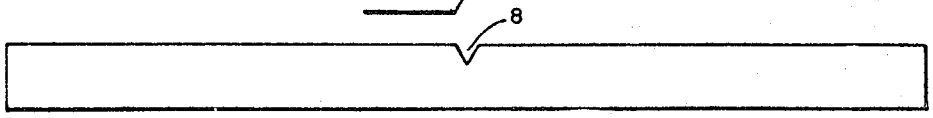


Fig. 4



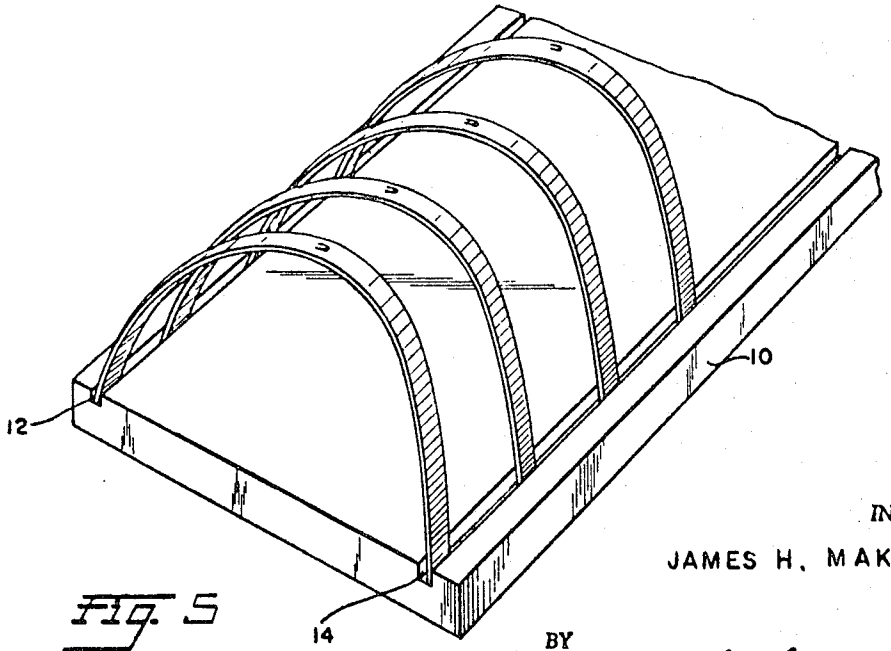


Fig. 5

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METHOD FOR QUICKLY DETERMINING HYDROGEN EMBRITTLEMENT OF METALLIC PARTS

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U.S. Cl. 73—87 1 Claim

ABSTRACT OF THE DISCLOSURE

Method for testing for hydrogen embrittlement of ferrous parts which have been subjected to a process or cycle which causes the part to absorb hydrogen such as, for example, an electroplating bath, an acid cleaning bath, a pickling bath or the like, any or all of which are hereinafter referred to as a "bath," and for the efficiency of a subsequent baking operation to remove hydrogen, in which an elongated ferrous strip, which is weakened at its midpoint, is subjected to the same bath and subsequent baking operation, and is then bent to U-shape and held in that condition to failure, the time to failure being measured and being inversely indicative of the extent of hydrogen embrittlement of the parts.

Summary of the invention

Hydrogen embrittlement of ferrous and ferrous alloy parts results either in the inability to withstand dynamic shock or the propagation of existing fissures when the part is put under load, and such embrittlement requires that the hydrogen be removed or the part be rejected. It is therefore necessary to determine whether embrittlement is present, but while earlier work on this subject has shown that hydrogen embrittlement can be measured by a ductility or static load test of notched specimens, no practical way has been known to measure embrittlement by a simple, quick and inexpensive test which can be used to test production plating lots of ferrous parts.

It has been the principal object of the invention to provide such a test which will be simple to perform, which can be performed simultaneously with the processing and baking of springs or other parts, which will accurately measure the degree of hydrogen embrittlement due to the bath, the efficiency of the baking cycle in removing hydrogen, and which will provide results very quickly, thus permitting additional baking of the springs if this is required.

When springs or other parts made of a ferrous or ferrous alloy material are subjected to a process which causes absorption of hydrogen with consequent embrittlement, such as a bath as herein described, the hydrogen is conventionally wholly or partially removed by baking. It is desirable and necessary to know quickly the extent of residual embrittlement after baking in order to subject the parts to additional baking if this is required, and in accordance with the invention it is proposed to measure hydrogen absorption by forming a strip of standard predetermined dimensions, structure and composition subjecting this to the same bath and baking oven as the springs or other parts, then placing the strip under stress by bending it through a pre-determined arc and measuring the time to fracture, which I have determined to be inversely proportional to the degree of embrittlement.

Description of the drawings

FIG. 1 is a plan view of a preferred form of test strip according to the invention;

FIG. 2 is a side view of the strip shown in FIG 1;

FIGS. 3 and 4 are, respectively, plan views of two other forms of test strips according to the invention, and

FIG. 5 is a perspective view of a test rack with test strips in test position thereon.

Description of the invention

In carrying out the invention there are first provided elongated flexible test strips of substantially identical construction and physical characteristics, preferably formed of SAE 1075 and carefully standardized with respect to chemical composition, hardness, shape and size, and size and sharpness of the notch forming the weakened center section. One or more of these strips is subjected to the same bath and baking operations as the parts, and then bent to substantially U-shape and held in this condition to failure. The time to failure from completion of the bath cycle, or the baking cycle if there is one, is measured and is substantially inversely proportional to the degree of hydrogen embrittlement of the parts. The test strips have the value that, having gone through the same embrittling and baking operations as the parts, they will quickly tell the degree of hydrogen remaining in the parts. The exact correlation between the time of breaking of the test strips and failure of the parts from hydrogen embrittlement must be determined by actual test experience. The shape of the parts, any sharp discontinuities formed in them, the thicknesses of various sections, the chemistry of the material, and the stress to which the parts will be subjected in use vary greatly, and correlation between the life of the standardized test strip and the probability of part breakage must be determined by testing the test strips against actual times to part failure. In general, it may be said that the time to failure of a test strip is inversely proportional to the amount or residual hydrogen remaining in the parts.

The test apparatus provided by the invention comprises bendable test strips and a rack for holding the strips immobile in U-shaped condition after the bath and baking cycles. Test strips which have proved to be successful are shown in FIGS. 1 to 4 and it will be seen that each comprises an elongated, narrow, thin, normally flat strip of ferrous metal notched or otherwise weakened at its center. The preferred strip construction shown in FIGS. 1 and 2 has a U-shaped cut **2** leaving a tab **4** slightly bent outwardly from the plane of the test strip. The strip of FIG. 3 has a partially sheared out button **6** at the same location as the tab **4**, while the strip shown in FIG. 4 has a V-shaped edge notch **8** midway of the length of the strip. The rack which completes the test apparatus comprises a flat board **10** having two parallel grooves **12, 14** in its one surface which are spaced apart by such a distance that when the ends of a test strip are placed in the grooves the strip will be bent to substantially U-shape as shown in FIG. 5. Obviously, parallel strips or the like could be used instead of grooves. Test strips having, respectively, the three notch types are sensitive indicators, but strips having the U-shape notch of FIGS. 1 and 2 are preferred because the notch may be produced more uniformly.

A test strip which has proved to be successful is 7½ inches long, ½ inch wide and .022 inch thick, having the U-shaped cut and tab of FIGS. 1 and 2, the tab being ⅛ inch wide, the material of the strip being 70/80 carbon steel hardened and tempered to a Rockwell 30 N scale (equivalent to Rockwell C 55/56 on the A scale). Such a strip is used with a rack having grooves which are spaced 3½ inches apart.

I claim:

1. The method of testing the extent of hydrogen embrittlement of a ferrous or ferrous alloy part, such as a spring, which has been subjected to a bath in which it may absorb hydrogen and then baked to remove hydrogen, which consists in subjecting to the same bath and any subsequent baking cycle as the part an elongated, narrow, thin strip

of ferrous alloy material, bending the strip about its center to substantially U-shape, holding the strip in bent position to failure, and measuring the time to failure.

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