Dec. 5, 1933. L. E. HOWARD 1,937,820

METHOD OF TESTING STEEL

Filed Dec. 17, 1929

Fig. 1

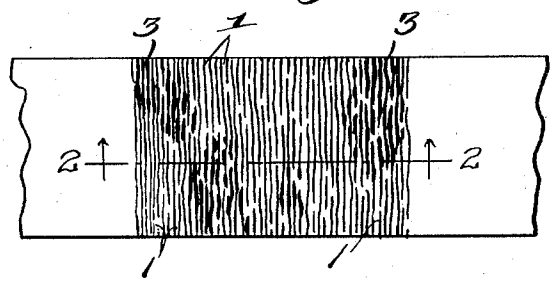
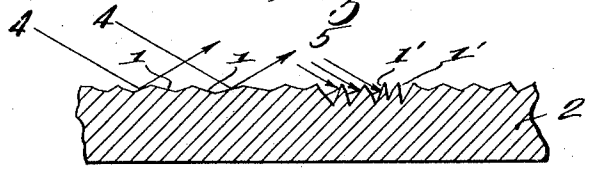


Fig. 2



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METHOD OF TESTING STEEL

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5 Claims. (Cl. 73—51)

This invention relates to a method for the detection of soft spots in steel which has been subjected to heat hardening treatments.

It is well known in the steel industry that when a casting or any other kind of steel product is subjected to heat treatment for hardening the same, portions of the article may remain relatively soft, even though the remainder of the article has been hardened to the maximum degree required.

Heretofore, it has been customary to inspect such products by etching the surface with acids of various kinds (such as hydrochloric or sulphuric) to dissolve the superficial coating of oxide which ordinarily develops in the course of manufacture and thus enable one to detect irregularities, which may have been developed, by the character of the etching action of the acid. Some experience is required to interpret the results observed and the method involves the consumption of a considerable quantity of acid, together with the inconvenience of the necessity of washing and drying each article after its examination. The presence of acid in a shop is of itself undesirable, if it may be avoided.

Accordingly, it is an object of this invention to provide a method whereby the soft spots occurring in a hardened steel product of any kind may be clearly revealed and positively identified, without requiring more than casual instruction of the operator and without necessitating the use of chemical reagents. Other objects will appear from the following disclosure.

It is found, as a part of the present invention, that the surfaces of hardened steel objects may be uniformly and completely cleaned, whether rough or smooth, and whether containing reentrant angles, depressions, and the like or irregular protuberances (which may be difficult to reach) by subjecting the same to the abrasive action of relatively sharp and preferably coarse abrasive particles such as sand, chilled iron, alloy steels (of such composition as to render them hard) or still harder abrasives such as the natural and artificial abrasives, corundum, fused alumina, silicon carbide, boron carbide, tungsten carbide, and the like of which there is a large number.

An outstanding qualification of the abrasive to be used, is that it shall quickly cut and remove the surface of the hardened steel object to be examined, but it need not be a rapid-cutting abrasive with respect to the hardened steel below. In fact, only slight abrasion or wear upon such parts is usually desirable, especially if the object has been partially or completely finished before the hardening operation. As will appear hereinafter, it is only necessary that the abrasive shall be harder than the soft spots to be detected.

The application of the invention will be described with respect to the examination of steel saw blades the surface of which, treated for testing and examination purposes, is illustrated by the accompanying drawing, in which:

Fig. 1 is a plan vew of the surface of the blade; and

Fig. 2 is an enlarged cross section of the same in the plane 2—2 of Fig. 1.

The blades may be shaped in the usual manner, and then subjected to heat treatment in accordance with any customary practice. The hardened blade is subjected to a blast of compressed air, into which a constant stream of the granular abrasive, such as spent molding sand or preferably a fairly coarse sharp sand 30 to 36 (mesh), is gradually fed. The quantity of abrasive is preferably kept low, inasmuch as this renders the individual particles more effective on the one hand and on the other avoids too great removal of the surface which is under treatment. It also enables the operator more closely to observe the scoring or cutting action. Nevertheless, the surface is promptly and uniformly cleaned throughout or over such areas as experience may determine as most susceptible to soft spots.

If the cleaned surface is uniformly bright in appearance (due regard being taken of the shadow effects of uniform scratches or cuts, especially if they are deep) it indicates that the article is free from soft spots and has been uniformly hardened by the hardening treatment. On the other hand, if there are soft spots which in any place reach to the surface, they are immediately manifest by the appearance of areas in which the sand blast has had a very different effect, usually resulting in producing a darker surface, which is also less directly reflective to light, and hence duller in appearance. The size of the soft spot is indicated by the size of the dark area; and the degree of softness is indicated by the degree of darkness of the spot and by the uniformity or non-uniformity of darkness throughout its area. The shape and size of the spot, (and its position relative to others) will give some further indication as to the probable depth or thickness of the spot.

A closer examination of the surface may be made microscopically if desired, and is especially applicable to the margins of the softer spots to detect the causes of their occurrence. It may

also prove useful with respect to the degree of hardness of the properly hardened portion as well as of the soft portion of the article being tested.

Thus the cuts 1, 1', produced in the surface of the metal 2, may be wholly irregular, or, as indicated in Fig. 1, more or less parallel to each other; but, if made by uniformly sized abrasive grains they are usually of approximately equal width. In the softer spots 3, 3, the abrasive grains penetrate deeper, as shown in Fig. 2, so that while light rays 4 are reflected from the fresh surfaces of the shallower cuts 1, rays 5 are absorbed or totally reflected from the deeper cuts 1', thus making the latter appear dark when viewed, for example, by an observer at the right hand side of the figure.

With coarser abrasives and/or higher air pressures, the abrasion will be more drastic and the individual cuts deeper. Conversely, with finer and/or lower air pressures, the cuts will be shallower and the material removed will be less. In any case, for accurate inspection, it is preferable to employ a granular abrasive of relatively uniform grain size, in order to make the individual cuts of a more uniform and regular size on those portions of the steel which are of uniform hardness. Otherwise, a combination of very coarse and very fine cuts or scratches may make examination difficult and lead to an incorrect interpretation of the results. Likewise, it is well to maintain a fairly uniform air pressure and rate of feed of abrasive grain while blasting a given article.

The effect obtained by the invention may be attributed to the differential cutting action of an abrasive grain, under a uniform average pressure or impact, upon a hardened steel surface which it may cut (even though slightly) and upon a softer surface which it will cut deeper, under the same conditions. This difference in depth of cut produces a series of scorings which, though usually substantially identical, exhibit the phenomenon of total reflection, resulting in the absorption of light and produce in those areas of deeper cuts, an area of greater total reflection (i. e. absorption) of light (especially when directed transversely of the scorings) than those where only light, shallow cuts have been produced. Hence, only extremely small differences in depth of cut in such surfaces are accompanied by marked contrasts which may be readily observed upon only casual inspection.

The hardened products in which soft spots are detected may of course be rehardened in the customary manner before further operations have been carried out upon them, thus saving the expenditure of labor upon articles subsequently to be found defective and avoiding the output of articles which, though defective, are not suspected and may fail at a critical point in their subsequent operation or use.

It will be readily understood that the invention may likewise be applied to objects which are predominantly soft for spots which are, by comparison, hard.

I claim:

1. Method of testing metal products for soft spots which comprises abrading or polishing the surface with an abrasive material which produces scores therein characterized by severally exhibiting depths varying substantially in proportion to the relative softness of the surface, illuminating the same and observing the light effects exhibited by the surface indicating the relative degrees of softness and hardness therein.

2. Method of testing heat hardened metal products for the detection of soft spots therein, which comprises the step of subjecting the surface of the same to the impact and cutting action of abrasive particles under a uniform, but yielding momentum and pressure, thereby to clean and cut the surface in scores characterized by exhibiting depths varying substantially in proportion to the relative softness of the surface, illuminating the same and observing the light effects exhibited by the surface indicating the relative degrees of softness and hardness therein.

3. Method of testing heat hardened steel products for the detection of soft spots therein, which comprises the step of subjecting the surface of the same to the action of abrasive particles of uniform size and under a uniform but yielding pressure, which produces a series of parallel scores characterized by exhibiting depths and widths, uniform in surfaces of uniform hardness and varying in proportion to the relative degrees of softness in surfaces which are not uniform, illuminating the same and observing the light effects exhibited by the surface indicating the relative degrees of softness and hardness therein.

4. Method of testing heat hardened steel products for the detection of soft spots which comprises the steps of subjecting the surface of the same to the impact and abrasion of a stream of abrasive particles carried in a stream of air under uniform pressure, which produces scorings in said surface, substantially parallel and proportionate in depth and width to the relative degree of softness thereof, illuminating the same, and observing the relative degrees of light absorption exhibited by the surface, indicating corresponding degrees of softness, if any, therein.

5. Method of testing heat hardened steed products for the detection of soft spots, which comprises the steps of subjecting the surface of the same to the impact and abrasion of a uniform stream of abrasive particles carried by a stream of air under uniform pressure, which produces scores in said surface, substantially parallel and proportionate in depth and width to the relative degrees of softness presented by the surface, illuminating the scored surface with substantially parallel light transversely of the scorings and observing the relative degrees of light absorption (or total reflection) exhibited by the scoring as indicating the relative depths produced and the corresponding degrees of softness of said surface.

LESLIE E. HOWARD.