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HEAT TREATMENT OF METAL ARTICLES HAVING HOLES THEREIN

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Fig. 1.

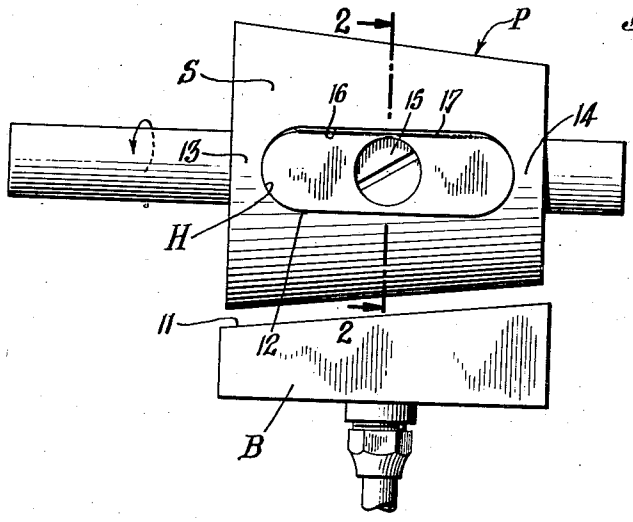
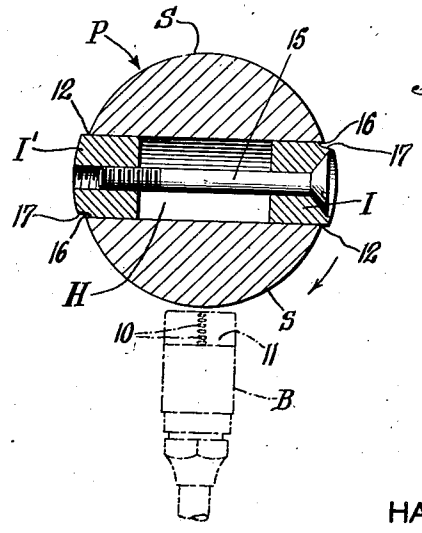


Fig. 2.



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HEAT TREATMENT OF METAL ARTICLES HAVING HOLES THEREIN

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6 Claims. (Cl. 148—21)

This invention relates to the heat treatment of metal articles having holes therein. More particularly, this invention relates to the hardening of a surface of a ferrous metal article having a hole or holes therein, wherein the surface to be hardened is heated by a source of high temperature heat, such as an oxy-acetylene blowpipe flame. Such holes may be cavities, i. e., holes extending only partially through the article, or slots, i. e., relatively wide elongated holes extending completely through the article; such holes may be round or cylindrical in shape, or have any other shape, regular or irregular; and the surface to be hardened may border on all or only a part of such hole, cavity or slot.

In one method of hardening a surface of a ferrous metal article, successive portions of the surface are heated by directing thereagainst, from an oxy-acetylene blowpipe, one or more high temperature heating flames; and the heated surface portions are cooled immediately after heating by directing thereagainst a jet or jets of cooling or quenching medium, such as water. In another method of hardening a surface of a ferrous metal article, the entire surface is heated by effecting a relative movement or reciprocation between the flames and the surface, and then the entire heated surface is cooled or quenched. In either method, it is difficult to obtain uniform hardening of surfaces which border on holes. The edge or edges of the hole, i. e., parts of the surface bordering on a hole, tend to become overheated since there is less metal to conduct heat away from an edge of the hole, than from the remainder of the surface.

Among the objects of this invention are to provide a method of heat treating a surface of a metal article having a hole therein whereby the edge of the hole is prevented from being overheated; to provide such a method in which that part of the surface at the side of the hole will be heated substantially to the same temperature as the remainder of the surface; to provide a method of hardening a surface of a metal body having a hole therein in which a uniform hardness over the entire surface is produced; to provide a suitable heat conducting insert for use in carrying out the above method; to provide such an insert which will not only prevent one edge of the hole from being overheated but will also permit the opposite edge to be heated rapidly when the heating flames move across the hole from the first to the latter edge; and to provide such a method by which the depth of case at either edge of the hole may be controlled. Other objects and novel features will become apparent from the following description and accompanying drawing, in which:

Fig. 1 is a top view, looking downwardly, illustrating the treatment of an article having a hole, in accordance with this invention; and

Fig. 2 is a vertical sectional view of the article of Fig. 1, taken along line 2—2 of Fig. 1, with the heating means of Fig. 1 shown in phantom outline.

In general, an article having a hole therein is treated in accordance with this invention by inserting in the hole a heat conducting insert which is adapted to conduct heat away from the edge of the hole and thereby prevent overheating thereof. The insert may be formed of any material having a relatively high rate of heat conduction, but it is preferred to form the insert of copper, or similar material, which will not be hardened by the heating and subsequent cooling of the surface being treated, so that the same inserts can be used again to secure similar results in treating other articles.

In the accompanying drawing, the treatment of a valve plug P having a hole H, such as a slot extending therethrough, is illustrated, but it will be understood that other articles having holes therein may be treated in a similar manner. However, it is extremely difficult to surface harden valve plugs effectively in any other manner, and the treatment of valve plugs is consequently a relatively important specific phase of this invention.

The valve plug P is mounted in a suitable manner for rotation about its axis in the direction of the arrows of Figs. 1 and 2, so that successive portions of the surface S of the plug will be heated by high temperature heating flames directed thereagainst from outlets 10 of blowpipe B. Outlets 10 are drilled in blowpipe B, and terminate in a face 11 of the blowpipe, the face 11 preferably corresponding in shape and being disposed parallel to a transverse section of surface S. A plurality of nozzles may be substituted for outlets 10, or any other suitable manner of heating the surface may be utilized. For instance, a plurality of electric arcs, or an electrical induction heating element, may be used to heat surface S.

The blowpipe B is supported in a stationary position in any suitable manner while the valve plug is rotated, but it will be understood that the valve plug may remain stationary and the blow-

pipe moved, or a combination of movement of both the valve plug and the blowpipe may be utilized. The desired effect is a relative motion between the article to be treated and the blowpipe so that successive portions of the surface of the article will be heated to a temperature at or above the critical range.

As the valve plug is rotated, edges 12 of hole H, which may be termed the "leading" edges, ordinarily will tend to become overheated because there is less material to conduct heat away from these edges, as from, for instance, surface portions 13 and 14 located at either side of hole H. To overcome the tendency for these edges to become overheated, and to conduct a sufficient amount of heat away from these edges so that they will be heated to the proper temperature and to the same depth as the adjoining surface portions 13 and 14, inserts I and I' are placed in the opposite ends of hole H. Inserts I and I' correspond in shape to the hole H, preferably being formed so that they fit snugly in the hole. A bolt 15, which connects the two inserts, may be used in adjusting the position of the inserts inwardly or outwardly of the hole and for retaining the inserts in any desired or adjusted position.

The inserts I and I' are preferably formed of copper, but may be formed of other metal, or even non-metallic material, such as carbon paste, the latter having been found suitable in many instances. Inserts I and I' preferably extend a slight distance above surface S at the leading edges 12 to obtain a uniform depth of case. It has been found, by experiment, that the depth of hardened case produced at edges 12 may be controlled by regulating the relative height to which inserts I and I' extend above or below surface S at these edges. When the top of the inserts are flush or level with the surface, the case produced at edges 12 will be deeper than over substantially the remainder of the surface, and the depth of case at edges 12 will decrease in accordance with an increase in the height of the inserts above the surface, and vice versa. Since a uniform depth of case is normally desirable, the inserts are consequently placed with their tops slightly above the level of the surface. However, if different case depths are desired, either or both inserts may be placed with the tops of the inserts at corresponding distances above, or even slightly below, the surface.

The leading edges 12, which absorb heat from previously heated surface portions, will, of course, be prevented from becoming overheated by the inserts I and I', but the opposite edges 16, which may be termed the "trailing" edges, will be relatively cold as the heating flames impinge upon them. To permit the trailing edges 16 to be hardened to the same depth as other portions of the surface which are unaffected by the inserts I and I', the inserts are cut away as at 17. These cut-away portions permit the trailing edges to be heated as rapidly and to substantially the same temperature and depth as the surface portions to either side thereof. As in the case of the leading edges, the depth of case produced at the trailing edges can be controlled by regulating the relative height of the inserts with respect to the surface at the trailing edges.

To cool the successive heated surface portions rapidly to effect hardening of the same, suitable means (not shown) for directing a quenching jet or a plurality of quenching jets against the heating surface may be provided. Such means may comprise a nozzle or nozzles positioned adjacent blowpipe B, or outlets drilled in blowpipe B alongside outlets 10 and supplied with a suitable quenching medium. In case the article is formed of air-hardening steel, or similar ferrous metal, such quenching means normally will not be necessary.

While the treatment of the valve plug P has been described with reference to the first method of hardening previously described, in which successive surface portions are heated and then quenched, the principles of this invention are applicable to the treatment of a surface by the second method of hardening previously described, in which the entire surface to be hardened is first heated, and then quenched. In the former method, the valve plug P may be rotated at a relatively slow rate, such as at about 1 R. P. M., and in the second method, the valve plug may be rotated in front of the heating flames at a relatively rapid rate, such as between 60 and 120 R. P. M.

It will be understood that the principles of this invention may be utilized in methods other than the two specifically referred to, and that the term "surface" is not to be restricted to a complete surface as usually understood, but applies as well to only a part of a surface. It will be further understood that the principles of this invention may be applied to any article having one or more holes, whether extending completely through the article or only partially therethrough; that inserts I and I' may be replaced by a single insert extending completely through the hole H; that inserts formed of material other than copper may be employed; and that other changes may be made without departing from the scope of the invention.

What is claimed is:

1. In a method of hardening a surface of a metal article having a hole therein, the steps comprising placing a heat-conducting insert in said hole to prevent overheating of an edge thereof; applying high temperature heat to said surface; and controlling the depth of hardening at an edge of said hole by regulating the relative height of said insert with respect to said surface.

2. In a method of hardening a surface of a metal article having a relatively wide elongated hole therein, the steps comprising placing a heat-conducting insert in said hole to prevent overheating of the edges of said hole; applying high temperature heat to said surface; and controlling the depth of hardening at each edge of said hole by regulating the relative height of said insert with respect to said surface at each edge of said hole.

3. A method of heat treating a surface of a metal article having a hole therein, comprising positioning a source of localized high temperature heat in operative relation with respect to said surface; placing a heat-conducting insert in said hole so as to prevent overheating that part of said surface bordering on said hole, said insert being placed so as to extend outwardly above said surface at one edge of said hole and inwardly below said surface at the opposite edge of said hole; and effecting a relative movement between said article and said source of heat in a direction such that the outwardly extending portion of said insert will be traversed by said source of heat before the opposite portion of said insert is traversed.

4. A method of heat treating a surface of a metal valve plug having a slot extending therethrough, which comprises positioning a source of high temperature heating flames so as to heat a portion of said surface; placing a heat-conducting insert conforming in shape to said slot in each end of said slot so as to prevent overheating of the edges of said slot at each end thereof; and effecting a relative movement between said valve plug and said heating flames so as to apply said heating flames to successive surface portions of said valve plug, each insert extending above said surface at the edge of said slot first reached by said heating flames and extending below the surface at the edge of said slot subsequently reached by said heating flames.

5. In a method of heat treating a surface of a metal article having a hole therein, wherein successive portions of said surface are heated to a hardening temperature by a source of high temperature heat, the steps comprising placing a heat conducting insert in said hole, and varying the relative height of said insert with respect to an edge of said hole to obtain the desired depth to which said surface is heated to a hardening temperature at said edge, said insert being placed so as to extend slightly above an edge which is heated subsequent to adjacent surface portions, to obtain substantially the same depth of heating at said edge as over surface portions remote therefrom, and the height of said insert relative to such edge being decreased to obtain a lesser depth of heating.

6. In a method of heat treating a surface of a metal article having a hole therein, as defined in claim 5, in which said insert is also placed so as to terminate below an edge which is heated prior to adjacent surface portions to obtain substantially the same depth of heating at such edge as over surface portions remote therefrom.

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