No. 660,720. Patented Oct. 30, 1900.

E. CHILDS.

PROCESS OF DETERMINING HARDENING HEAT FOR STEEL.

(Application filed Feb. 27, 1900.)

(No Model.)

Fig. 1.

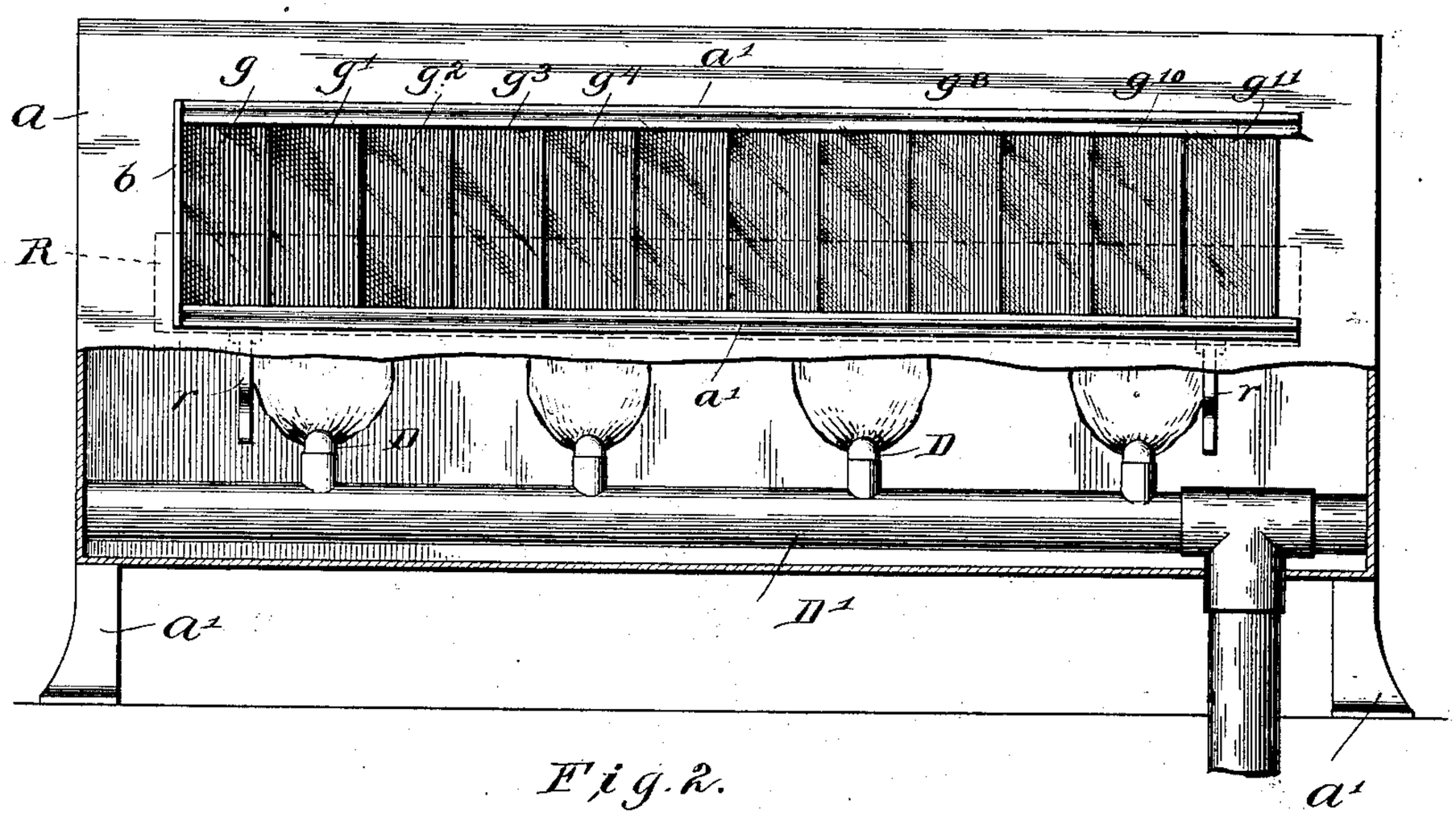


Fig. 2.

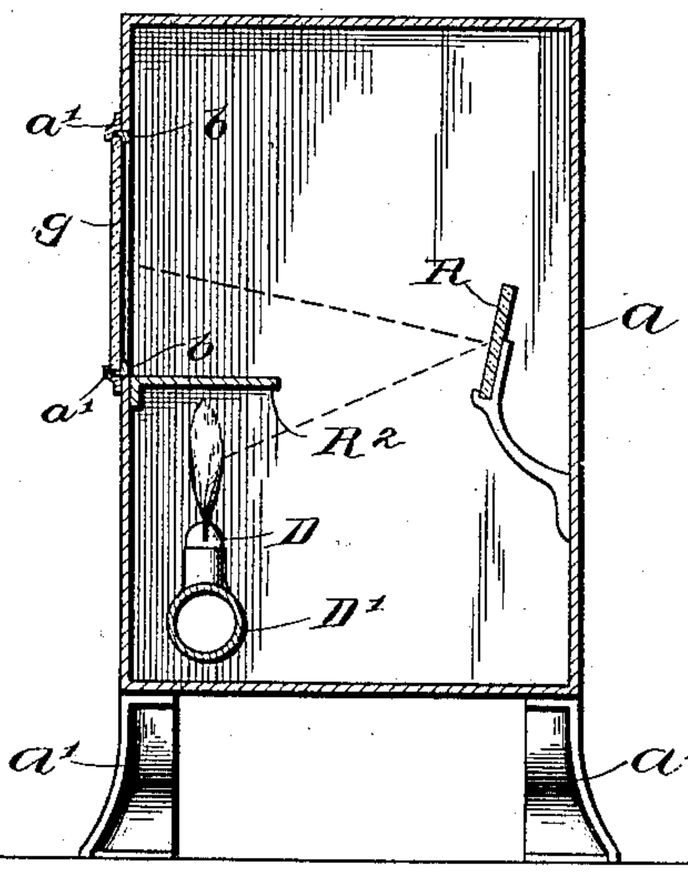
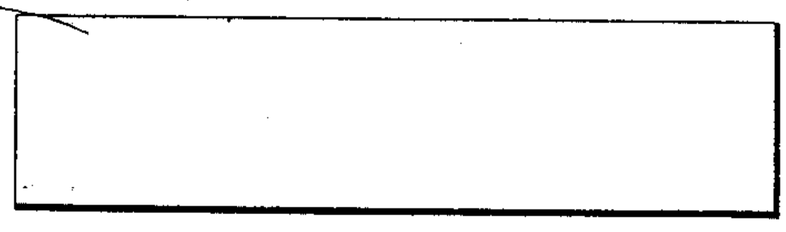


Fig. 3.



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UNITED STATES PATENT OFFICE.

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PROCESS OF DETERMINING HARDENING HEAT FOR STEEL.

SPECIFICATION forming part of Letters Patent No. 660,720, dated October 30, 1900.

Application filed February 27, 1900. Serial No. 6,673. (No specimens.)

To all whom it may concern:

Be it known that I, EUGENE CHILDS, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Determination of Hardening Heat for Steel, &c., of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention has for its object the production of a simple, accurate, and rapid process for determining the proper hardening heat for steel or other metal when it is desired to attain substantially uniform results in the finished product.

As my invention is particularly adapted for use in hardening steel, I will explain it fully in such connection, though it will more clearly appear hereinafter that the invention is not restricted thereto.

Manufacturing concerns purchase steel by analysis, and it frequently happens that while one lot will run very even the very next lot, which is supposed to be of the same analysis, may be different, necessitating a difference in its treatment when subjected to the hardening or tempering process. Directions for heating usually depend on color, and different workmen told to heat to a bright yellow will often get a difference of several hundred degrees by following the directions; but by my mode of procedure such variations are practically eliminated and a uniform product is obtained.

My invention is based upon the well-known fact that the colors in a heated portion of a piece or bar of metal gradually increase in brightness or brilliancy from the cool to the hottest portions, corresponding to the increase in temperature, and the problem to be solved is the determination of that particular tint or shade which corresponds to the temperature required for hardening the piece of metal. I proceed, therefore, to construct a test color-scale composed of narrow strips of glass of different shades of yellow placed side by side, ranging from dark to very light yellow, in treating steel, and conforming as nearly as may be to the grading in the heated metal. The strips are supported in a suitable frame in a vertical position and illuminated by transmitted light, and the heated bar is placed in front of the scale and moved along until the colors on bar and scale correspond as nearly as possible. In heating the bar or portion of metal to be tested it is placed in an ordinary blacksmith's fire which is hottest at the center, and obviously that part of the metal at the center of the fire will be heated to the highest temperature, and the temperature to which the heated portion of the metal is subjected between such maximum and the minimum or cold portion outside of the fire will gradually decrease from the maximum, so that the heated portion of the metal is subjected to a graded heat ranging from minimum to above maximum temperature requisite to properly temper the same, and the problem in hand is to determine what degree of temperature between those limits is proper for that particular metal to attain the desired hardness by subsequent quenching. A mark is made with chalk or by a nick on the bar, preferably opposite the darkest part of the scale, although any particular shade may be taken as the index, or, if desired, the bar may be marked opposite each division of the color-scale and the heated portion of the bar is plunged in the cooling medium. The heated portion of the bar will thus be hardened differently at different points owing to the gradation of temperature of such heated portion, and I preferably break off pieces therefrom, beginning at the part which was hottest and carefully noting the appearance of each successive fracture, which shows the condition of the metal thereat. When the fracture denotes the hardening desired for the use to which the steel is to be put, I again place the bar opposite the color-scale in the position it was marked while heated and note the particular color division opposite the fracture, which division shows the proper color to be attained for hardening. When a piece of steel is properly hardened and at the same time possesses the maximum toughness, the grain upon fracture appears to the eye to be fine, even, and silky in appearance, and is readily recognizable to those skilled in the art. To properly harden and attain such appearance upon fracture, it is necessary that the heating prior to cooling by

quenching shall approach but not exceed a certain critical point, which critical point is of course different in different steels. If the critical point is passed in the heating, the appearance of the fracture after quenching and cooling is coarse, granular, and irregular, and the same is true if the critical point is not approached within close limits. Steel showing the coarse granular fracture, while very hard, will be very brittle and not adapted for many purposes. It will therefore be manifest that by examining the fracture of a hardened piece of steel the character of the steel can be very accurately determined, and it is a common practice in steel-mills to determine the character of steel from different heats by fracture as well as by chemical analysis. I then remove the test-scale and substitute a larger piece of glass, corresponding to the tint or color thus found, and it is used in subsequently heating the balance of that particular lot of steel. This results in great uniformity in the finished product, and bright or cloudy days have no effect thereupon, for the transmitted light by which the test-scale or the working color is illuminated will not vary, whereas on a cloudy day there is ordinarily a tendency to underheat, with the opposite tendency to overheat on a bright sunny day.

I have shown in the drawings a simple form of apparatus by which my invention may be practiced.

Figure 1 is a front elevation thereof, partly broken out below the test color-scale. Fig. 2 is a transverse sectional view of the apparatus shown in Fig. 1; and Fig. 3 is a view, on a smaller scale, of a guide or working glass.

A preferably-closed box or chamber A, shown as mounted on legs A′, is provided in its front wall with an oblong opening *a*, along the upper and lower edges of which are placed guides *a′ a′*. The opening may be about six inches long and about an inch wide, though other dimensions may be adopted if desired. A series of upright narrow strips of glass *g g′ g²*, &c., about half an inch wide, are placed side by side in a light frame *b*, which slides in the guides *a′ a′*, so that the opening *a* is covered, the glass strips being graded from the darkest yellow at one end up to a very light yellow—nearly white—at the other end, as has been described, and constituting a test color-scale. The scale is illuminated by transmitted light, and I have herein shown a series of gas-burners D on a feed-pipe D′ within the chamber A, below the opening *a*, the light from the burner-flames being directed by a reflector R, supported on suitable brackets *r* at the back of the chamber, through the scale. A screen R^2, Fig. 2, is interposed between the scale and the direct light-rays from the burners.

If desired, the interior of the chamber may be blackened to prevent cross-reflections.

After the proper hardening color has been found, as described, the test-scale is removed and a large working or guide glass G′, Fig. 3, of that color is inserted in the guides *a′*, covering the opening *a*, and the workman uses it as his guide in hardening the remainder of the lot of metal. It will be manifest that each lot can be quickly tested, as has been described, either at the time it has been used or previously and the result recorded, so that by numbering the divisions of the test-scale and correspondingly numbering the guide-glasses G any tested lot of steel can be hardened when convenient.

Other metals can be hardened in accordance with my invention, it being necessary only to prepare the proper test color-scale and working glasses therefor.

In testing the cooled piece of metal for hardness it may be accomplished in any desired manner, as by filing, fracture, or otherwise, fracture being preferable as giving the clearest indication of the condition of the metal; but my invention is not limited to any particular mode of determining the hardness.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The process of determining the hardening heat for metal, which consists in subjecting a portion of the metal to be tested to a graded heat ranging from minimum to above maximum temperature requisite to properly temper the same, comparing such heated portion of the metal with a test color-scale graded in color to correspond to the gradations in temperature; indexing the portions thus compared, and cooling; testing such cooled portion for the requisite hardness; determining from the relative position of the properly-hardened portion the corresponding color division of the test-scale, and adopting such color for subsequent heating.

2. The process of determining the hardening heat for metal, which consists in subjecting a portion of the metal to be tested to a graded heat ranging from minimum to above maximum temperature requisite to properly temper the same, comparing such heated portion of the metal with a transparent test color-scale graded in color to correspond to the gradations in temperature; illuminating the scale by transmitted light; indexing the portion of metal compared with the scale, and cooling the same; testing the cooled portion for the requisite hardness; determining therefrom the corresponding color division of the test-scale, and adopting such color for subsequent heating.

3. The process of determining the hardening heat for metal, which consists in heating a portion of the metal to be tested to a graded heat ranging from minimum to above maximum temperature requisite to properly temper the metal and comparing such heated portion with a test color-scale divided vertically in color-bands corresponding to the grada-

tions in temperature; marking the portion of metal thus compared, and cooling the same; making successive fractures therein from the previously hottest portion, and determining from the relative position of the desired fracture the corresponding color division of the test-scale, and adopting such color as a guide for subsequent heating.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EUGENE CHILDS.

Witnesses:
JOHN C. EDWARDS,
EMMA J. BENNETT.