PUBLISHED

JUNE 1, 1943.

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LOW-FREQUENCY INDUCTION FURNACES FOR FUSING IRON ALLOYS

Filed Sept. 29, 1941

Serial No 412,885

Fig. 1

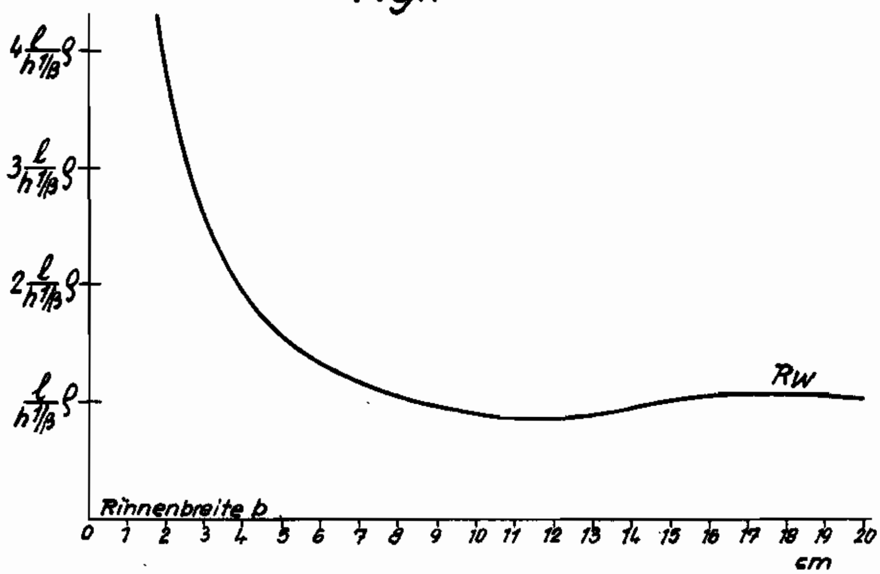
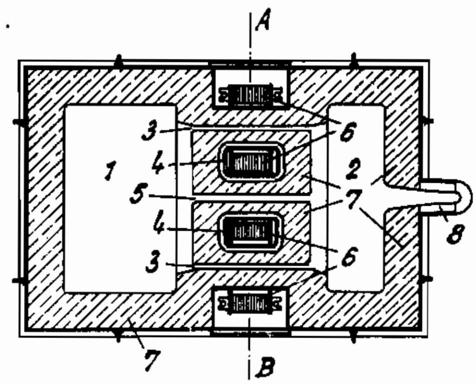


Fig. 2



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Published June 1, 1943 **Serial No. 412,885**

ALIEN PROPERTY CUSTODIAN

LOW-FREQUENCY INDUCTION FURNACES FOR FUSING IRON ALLOYS

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Application filed September 29, 1941

This invention relates to low-frequency induction furnaces for fusing iron alloys, particularly pig-iron castings and cast steel.

Low-frequency furnaces of the type hitherto known have as is well known a relatively complicated trough shape which calls for a particularly reliable furnace lining. When fusing metals at temperatures above 1000 degrees centigrade, the furnace lining is greatly stressed by the high temperatures. In addition, the intense agitation of the metal in the trough erodes the lining material which deposits on some points of the furnace where it is not desirable. The energy supply varies constantly so that an undisturbed operation for a considerable period can be ensured in some cases only. The temperature within the trough channel is also considerably higher than in the hearth. In brass melts in which temperatures slightly above 1000 degrees centigrade are in average employed, differences of temperature up to 150 degrees centigrade have been ascertained. These differences of temperature become still greater when fusing metals having a higher fusing point, such as, for instance, is the case with iron and pig-iron castings. Owing to the overheating of the metal in the trough, necessary for the fusion and the intense agitation of the metal in the bath, the masonry is attacked to a very great extent and withstands but a few melts. Improvements in the construction of low-frequency furnaces can therefore only be effected, if too great increases in temperature within the trough be avoided and the agitation of the bath prevented. When dimensioning the trough as has hitherto been usual, it is impossible to reduce the agitation of the metal in the trough, since otherwise an efficient energy supply is not possible. In the trough channel of the furnaces hitherto known, the current distribution over the cross-section of the trough is uniform. However, the magnetic lines of force over the cross-section are distributed in a very non-uniform manner so that an intense agitation of the metal in the bath must occur. However, if the trough is enlarged, the resistance of the fusing channel as is well known is reduced and therefore cos φ of the system so that condensers must be employed. Should the diameter of the trough or the width of furnaces of the rectangular type be small as is the case with the types hitherto employed, the alternating-current resistance decreases inversely proportional with the width of the trough. The alternating-current resistance therefore decreases if the trough becomes wider as a result of the erosion, thereby causing at the same time a decrease in the energy input.

In Fig. 1 are shown the above conditions graphically. The curve R_w shows the relations between the alternating-current resistance of a rectangular trough channel and the width b. The alternating-current resistance depends upon the frequency used and the conductivity of the metal fused which fills up the trough. The curve in Fig. 1 is computated for a frequency of 50 cycles and for pig-iron castings. In the case of cast steel the curve coincides substantially with that for pig-iron castings. When considering this curve, it results that the alternating-current resistance from a predetermined trough width, is practically dependent upon the trough width. A change in the cross-section of the trough has, therefore, no influence within this range on the conversion of energy. The alternating-current resistance tends to reach a limit value given by the following equation

$$R_w=\frac{1}{h.1/\beta}\cdot\varphi$$

where R_w is the alternating-current resistance, 1 the length and h the height of the trough channel. β is the absorption constantw hich is obtained by the following equation

$$\beta=2\pi.\sqrt{\frac{\mu.f}{\rho}.10^{-9}}$$

In this case it is assumed that ρ, the specific resistance of the metal fused be expressed in ohm/cm. The value of μ in the case of pig-iron castings is approximately 1. The frequency f is taken in the above instance as 50 cycles.

According to the invention the width b of the trough should be chosen in such a manner that the alternating-current resistance R_w is practically independent of the increase of the trough width. In this case, erosions which occur as a result of the agitation of the metal in the trough do not play any part for the fusing operation, since the energy input is no longer varied. Also cos φ does not vary. To this end, as will be seen from Fig. 1, the trough width must be greater than 12 cm. The distribution of current within the trough is not uniform. As a result of this non-uniform distribution of current, also the agitation of the metal in the fusing trough is brought about in particular ways. Only in the neighborhood of the lining material in the melt a pressure drop is to be expected which results in an agitation of the metal which is considerably slighter than in the case of the trough shapes as hitherto dimensioned. Owing to the large cross-section, the pressure drop between the trough and the hearth proper is reduced so that also overheating are much more seldom than has heretofore been the case. The temperatures in the trough are lower than hitherto by 100 to 200 degrees centigrade. In this manner, there results a smaller mechanical stress of the lining and furthermore, better qualities of the products produced are obtained. The efficiency of the entire system increases.

Fig. 2 shows a sectional view of a furnace with two hearths denoted by the reference numerals 1 and 2. The two troughs 3 lie exteriorly of the two induction coils 4 and have a width of more than 12 cm. By the width of the trough is understood the expansion in the direction A—B. The trough 5 arranged between the two induction coils is correspondingly wider at least 20 cm in the case of 50 cycles, since it is traversed from both sides by electromagnetical lines of force. The length of the trough is chosen in accordance with the desired input of the furnace. The laminated iron body is denoted by the numeral 6. 7 is the lining material. A casting lip 8 serves to cast the fused metal. It is preferable to use the hearth 1 as the hearth proper, into which the parts to be fused are charged and to effect the casting from the hearth 2. In this manner an homogeneous material is always attained for casting.

FRITZ WALTER.