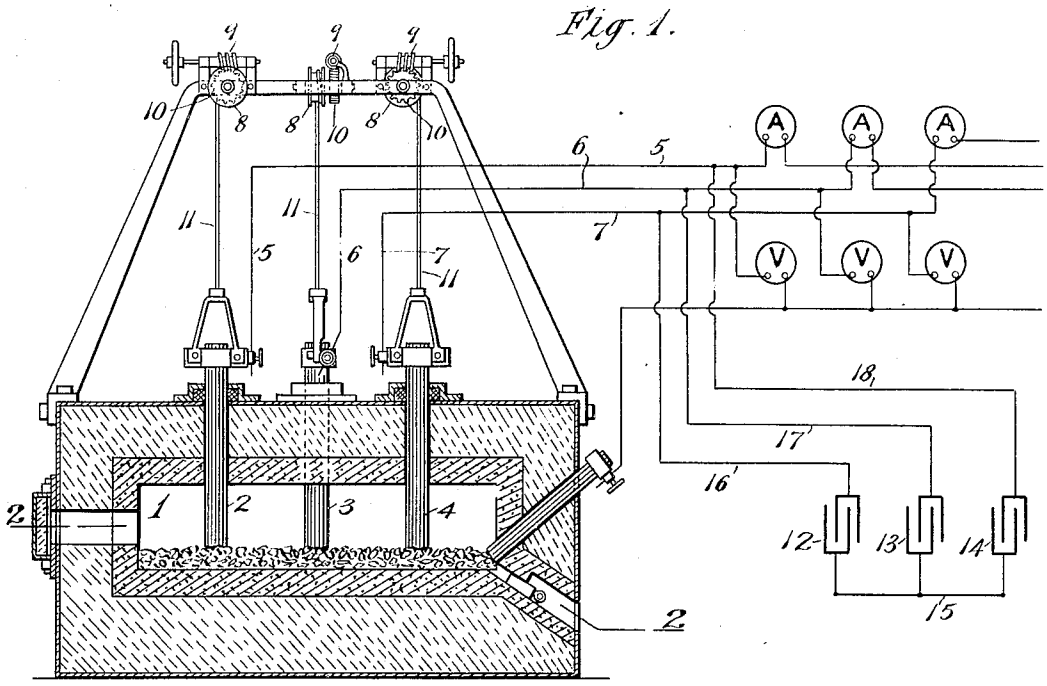
Dec. 25, 1923. 1,478,375

M. H. BENNETT

ELECTRIC FURNACE

Filed July 18, 1918

Fig. 1.



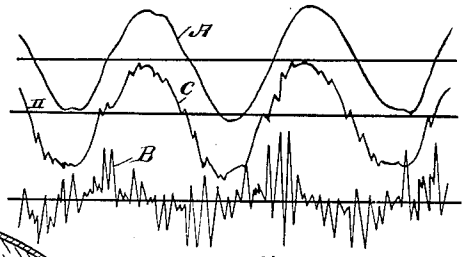
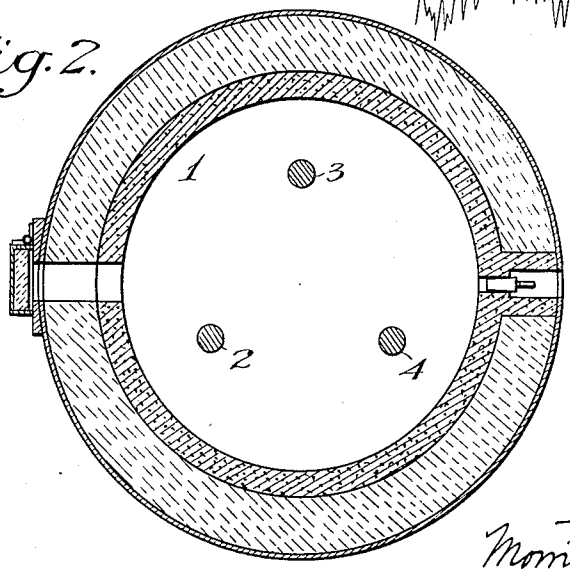




Fig. 3.

Fig. 2.




Inventor:
Morris H. Bennett
by his Attys:
Philipp Sawyer, Rice & Kennedy

Patented Dec. 25, 1923. 1,478,375

# UNITED STATES PATENT OFFICE.

MORRIS H. BENNETT, OF WATERBURY, CONNECTICUT, ASSIGNOR TO SCOVILL MANUFACTURING COMPANY, A CORPORATION OF CONNECTICUT.

## ELECTRIC FURNACE.

Application filed July 18, 1918. Serial No. 245,485.

*To all whom it may concern:*

Be it known that I, MORRIS H. BENNETT, a citizen of the United States, residing at Waterbury, county of New Haven, and State of Connecticut, have invented certain new and useful Improvements in Electric Furnaces, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to improvements in electric furnaces.

In electric furnaces as ordinarily constructed and in which the current is conducted directly from electrode to charge, generally speaking, the efficiency of the furnace is determined by the amount of energy which can be delivered to the charge in a given time.

In furnaces for melting metals having a high electrical conductivity and low resistance, and particularly such metals as tend to give off fumes in melting, this limitation is serious because, if it be attempted to force a large quantity of energy into the furnace in a short time, excessive temperatures are produced beneath and immediately around the electrodes, the result of which is a tendency to burn the metal, or cause excessive fumes, or both. Further, the high temperatures immediately beneath or around the electrodes and the heat which is radiated from the electrodes or from the zone between electrode and charge, raise the temperature in the furnace chamber to such an extent that such fumes as are given off produce excessive pressures in the furnace chamber, particularly if it be of the closed or Bennett type.

In such furnaces, furthermore, the effective current heretofore employed has been of low frequency, that is, approximately between fifteen and sixty cycles. This low frequency current, particularly where the charge is composed of metals having a high electrical conductivity is, as is well-known, so distributed through the charge that its resulting heating effect in the charge is comparatively low. As has been indicated, any attempt to increase the heating effect by substantially increasing the rate at which energy is introduced into the furnace by this effective low frequency current will result in excessive temperatures in the furnace, which is objectionable, particularly where the metals being melted tend to fume, and will result in excessive overheating of the metal immediately around and beneath the electrodes.

It is the object of this invention to employ in furnaces such as have been referred to, a current of such characteristics that the heating effect due to the passage of the current through the charge will be increased.

More specifically considered, it is the object of this invention to employ in furnaces such as have been described an effective heating current of high frequency, the heating effect being increased because the resistance of the charge to such current is high.

With these and other objects not specifically referred to in view, the invention consists in the combination with a furnace which employs means for conducting the electric heating current directly to the charge in the furnace, of means for supplying thereto an effective current of high frequency.

More specifically, the invention consists in employing in an electric furnace in which the current is conducted from electrode to charge, a low frequency generator, means being employed in connection therewith to increase the effective frequency of current delivered to the charge.

The invention also consists in certain elements and combinations as will be more fully described hereinafter and particularly pointed out.

Figure 1 is a diagrammatic view of a furnace and connected apparatus for carrying the invention into effect, the furnace being shown in section.

Figure 2 is a horizontal section of the furnace shown in Figure 1.

Figure 3 is a diagrammatic illustration, by means of curves, of the results obtained from the construction shown in Fig. 1.

The drawing forming a part of this specification illustrates diagrammatically a furnace and proper apparatus in connection therewith for carrying the invention into effect. The furnace which has been selected for illustration is a furnace of the closed or Bennett type, illustrated and described in connection with the application of M. H. Bennett, Serial No. 241,914, filed June 17, 1918, in which devices are shown for

controlling the rate of heat delivery as to prevent the undue production of fumes in the furnace. In said drawing, 1 indicates the furnace chamber and 2, 3, 4 the electrodes. The power circuit wires for the several electrodes are shown at 5, 6 and 7, respectively, ammeters and voltmeters being shown as connected on the circuits. Devices for properly positioning the electrodes to adjust the resistance are shown, these consisting of drums 8, worms 9 and worm-wheels 10. The connections from the worm drums to the electrodes are indicated at 11.

As has been indicated, furnaces which embody the invention will utilize effective currents of high frequency, that is, very considerably in excess of the low frequency currents ordinarily utilized in electric furnaces in which current is delivered directly from electrode to charge.

As is well-known, the use of high frequency generators for ordinary commercial work, such as furnace work, presents many difficulties. The expense of installation of such generators is large, and the electrical losses are high, particularly if the current requires to be transmitted over any considerable length of line. Preferably, therefore, in carrying the invention into effect, the effective high frequency utilized in the furnace will be obtained by increasing the effective frequency of current derived from a low frequency generator. In the commercial practice of the invention, an effective high frequency of about 1200 cycles has been obtained by increasing the effective frequency of current derived from a low frequency generator, the generator being designed to deliver a current of about sixty cycles.

The delivery of the effective high frequency current derived from a low frequency generator, when the high frequency is obtained in this manner, may be efficiently attained by employing a condenser or condensers. Condensers of various constructions may be employed. A condenser which has been found efficient is of the electrolytic type and consists of a series of closely spaced aluminum plates in an electrolyte consisting of a saturated solution of bicarbonate of soda. Three such condensers are indicated at 12, 13 and 14, respectively.

The condensers employed for carrying the invention into effect may be variously connected on the circuit. As shown, the connection is of the Y type, one set of the plates in each cell being connected by a common strap 15 and the other plates in the cells being connected by wires 16, 17 and 18 to the circuit wires 7, 6, 5 respectively.

It will be understood that in the construction shown, these circuits 5, 6, 7 lead to a suitable low frequency generator of the polyphase type, if necessary a suitable transformer being interposed in the circuit. As these devices are well-known, they are not indicated.

Actual commercial test of the apparatus which has been described, using a low frequency generator delivering a current of about sixty cycles and employing three condensers having a capacity of about 3200 microfarads each, has shown that a much higher temperature can be obtained and maintained in the metal, and, consequently, better heating, without undue production of fumes, than with the same apparatus without the condensers. This, of course, is highly advantageous where metals are being melted, the pouring temperature of which is necessarily considerably above the vaporizing point. The heating effect in the charge is increased without increasing the temperature in the furnace above the charge, so that such fumes as are given off are more readily condensed by the walls of the furnace chamber, the valuable metallic constituents which are carried by fumes being thus returned to the charge.

The results obtained by thus connecting a condenser into the circuit are indicated in Fig. 3. In this figure, the upper curve, marked A, represents the current in the transformer circuit and is a characteristic curve of the current obtained from an alternating generator. The lower curve marked B, represents the current in the condenser circuit and is a characteristic high frequency current curve. The intermediate curve, marked C, represents the current in the electric circuit due to the superposition of current B on current A. The irregularities in curve C indicate the higher frequency obtained from this superposition.

While the invention may be used with furnaces of other types, it is particularly valuable in connection with a furnace of the closed or Bennett type referred to.

It will be understood that changes and variations may be made in the particular construction shown and described. The invention is not, therefore, to be confined to such construction.

What is claimed is:—

1. The combination with a furnace for melting metals, of means for delivering a main heating current directly to the charge in the furnace, and means for impressing on said main current a heating current of high frequency, the resulting current producing improved heating effects in the furnace due to the resistance of the charge to said current.

2. The combination with a furnace for melting metals, said furnace having electrodes arranged to deliver current directly to the charge in the furnace, of a low frequency generator in circuit with the electrodes, and means also in circuit with the

electrodes for impressing on the main current a heating current of high frequency, the resulting current being delivered to the charge in the furnace by the electrodes and producing improved heating effects therein due to the high resistance of the charge to said current.

3. The combination with a furnace for melting metals, said furnace having electrodes arranged to deliver current directly to the charge in the furnace, of a low frequency generator in circuit with the electrodes, a condenser also in circuit with the electrodes and operating to impress on the main heating current a heating current of high frequency, the resulting current being delivered to the charge in the furnace by the electrodes and producing improved heating effects therein due to the high resistance of the charge to said current.

4. In the combination as claimed in 3, the condenser Y-connected on the circuit.

5. In the combination as claimed in 3, an electrolytic condenser.

6. In the combination as claimed in 3, an electrolytic condenser Y-connected on the circuit.

7. The combination with a closed furnace for melting metals, of means for delivering a main heating current directly to the charge in the furnace, and means for impressing on said main current a heating current of high frequency, the resulting current producing improved heating effects in the furnace due to the resistance of the charge to said current.

8. The combination with a closed furnace for melting metals, said furnace having electrodes arranged to deliver current directly to the charge in the furnace, of a low frequency generator in circuit with the electrodes, and means also in circuit with the electrodes for impressing on the main current a heating current of high frequency, the resulting current being delivered to the charge in the furnace by the electrodes and producing improved heating effects therein due to the high resistance of the charge to said current.

9. The combination with a closed furnace for melting metals, said furnace having electrodes arranged to deliver current directly to the charge in the furnace, of a low frequency generator in circuit with the electrodes, a condenser also in circuit with the electrodes and operating to impress on the main heating current a heating current of high frequency, the resulting current being delivered to the charge in the furnace by the electrodes and producing improved heating effects therein due to the high resistance of the charge to said current.

In testimony whereof, I have hereunto set my hand.

MORRIS H. BENNETT.