Dec. 11, 1934. H. INGELSRUD 1,983,544

ARRANGEMENT FOR SUPPLY OF CURRENT TO ELECTROTHERMIC MELTING FURNACES

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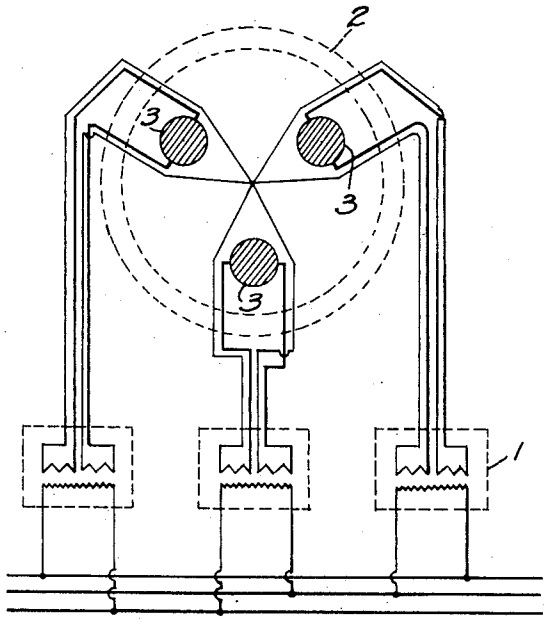


Fig. 1.

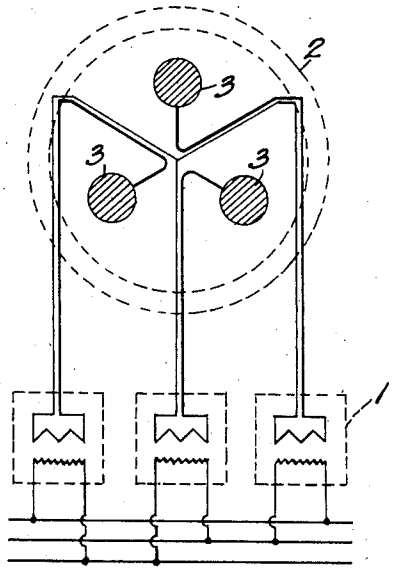


Fig. 2.

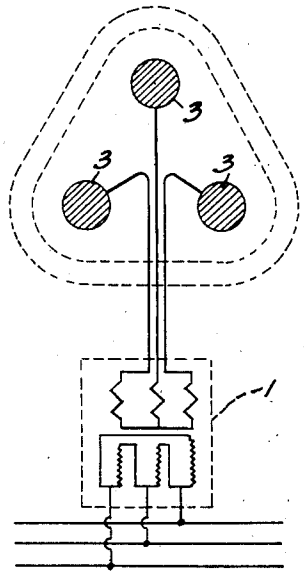


Fig. 3.

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ARRANGEMENT FOR SUPPLY OF CURRENT TO ELECTROTHERMIC MELTING FURNACES

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4 Claims. (Cl. 13—12)

As the inductive voltage drop in a conductor is approximately proportional to the amperage, the arrangement of the supply leads to the electrodes becomes a matter of the greatest importance. The big melting furnaces are most frequently three-phase furnaces and the transformers supplying current to such furnaces are on the primary side generally delta connected and on the secondary side either star or delta connected. By delta connecting the secondary side a favourable arrangement of the leads is obtained by taking the lead and return bars of the secondary winding from one transformer phase together up to the furnace and forming the delta connection near the electrodes or in the electrodes. If at the same time the three electrodes are placed in the corners of a regular triangle the dead phase will be completely avoided, as previously known.

In contradistinction to said delta connection, I employ a star connection on the secondary side and by special arrangement of the secondary leads attain very low inductive voltage drops.

Heretofore the three electrodes were generally placed in one plane and the neutral point of the star connection was either formed at the transformers or at the furnace where the flexible leads to the electrode began. If one three-phase transformer was used the neutral point of the connection was generally formed in the transformer and the three groups of leads from the three phases were in unison taken up to the furnace but again separated where the solid leads ended and the flexible leads began.

I place the electrodes in a triangle and take the leads up to the electrodes in such manner that the leads are compensated, that is not surrounded by any detrimental electromagnetic field, until they have passed the electrodes or reached a point within a circle through the three electrodes. The neutral point of the star connection may be formed either at a point within a circle through the three electrodes or in the transformer.

In the appended drawing Fig. 1 and Fig. 2 show a star connection with the neutral point in the axis of the furnace. The leads to the neutral point are somewhat thinner drawn than the leads to the electrodes.

Fig. 3 shows the neutral point formed at the transformer.

On the primary side the transformers are delta connected. In all three figures 1 designates the transformers, 2 the furnace and 3 the electrodes. As is known the secondary windings of big melting transformers are divided into a series of parallel coils, for instance eight. If the neutral point is not formed in the transformer eight lead and eight return bars of the secondary winding will leave the transformer cover. The current is best led to the furnace by means of water cooled copper pipes. According to Fig. 1 two groups of pipes from each phase lead to the corresponding electrode. Here the groups separate; the flexible leads pass on each side of the electrode up to the electrode holder and the rigid pipes are led to the neutral point within a circle through the electrodes. As there are equal numbers of lead and return bars of the secondary winding in the two groups of leads and as the flexible and the rigid leads are placed close to each other in two vertical planes the power fields of the leads are compensated all the way to the electrodes. Only the short pieces of the leads passing beyond the electrodes to the point within a circle through the electrodes remain non-compensated. Fig. 2 shows a current supply with the lead and return bars of the secondary winding in each phase carried all the way to the axis of the furnace from where the flexible leads go back to the electrodes. Fig. 3 shows a current supply which also has a very low inductive voltage drop and which only needs half the copper cross section required for an arrangement according to Fig. 2. The neutral point is formed in the transformer and the individual conductors of the three phases are carried all the way to the point within the circle through the electrodes. If, for instance, there are eight coils on each transformer core there will be a total of twenty-four copper pipes, eight from each phase, which are led to the furnace as close to each other as possible. The pipes may be arranged in triangular position to avoid any transmitting of energy from one exterior phase to the other.

Near the axis of the furnace the phases are separated and the copper pipes are connected with flexible leads conducting the current to the contact clamps of the electrode holders. These leads are spread out from each other as far as possible to make the electromagnetic field around each lead as small as possible. As these leads will be above the furnace they are made in the form of water cooled cables, that is, the lead consists of a core of fine-threaded and flexible cable surrounded by a flexible metal hose in which water circulates.

The star connection used in all these arrangements possesses in comparison with delta connection the great advantage that each individual electrode may be given just the voltage re-

quired for the moment. During operation it is sought to keep the electrodes at practically the same depth in the furnace and the transformers are therefore arranged for adjustment of voltage during operation. In the case of delta connection, however, all three transformers must operate with the same voltage as otherwise internal neutralization currents through the transformers may be developed. When using star connection each individual transformer may be adjusted independently and the transformers may thus supply the electrodes with different operating voltages.

I claim:

1. Arrangement of compensated current supply for electric multi-phase furnaces with star connection and with the electrodes arranged in equilateral triangle, characterized by the fact that the three phases are compensated all the way to a point within a circle through the electrodes.

2. Arrangement of compensated current supply for electric multi-phase furnaces with star connection and with electrodes arranged in an equi-lateral triangle and in which the lead and return bars of the secondary winding are compensated all the way to the electrodes, characterized by the fact that the return bars of the secondary winding pass the electrodes to a neutral point within a circle through the electrodes.

3. Arrangement of compensated current supply as in claim 2 characterized by the fact that the short uncompensated portions of the bars which lead to the neutral point are separated from each other as far as possible.

4. Arrangement of compensated current supply for electric multi-phase furnaces with star connection and with electrodes arranged in an equi-lateral triangle, characterized by the fact that leads from the secondary winding are compensated to a point within a circle through the electrodes and uncompensated for a short distance from such point to the electrodes, the short uncompensated portions of the leads being separated from each other as far as possible.

H. INGELSRUD.