The present invention relates to electric arc furnaces operating upon alternating current. A well known type of electric furnace comprises three electrodes disposed at the corners of an equilateral triangle, which electrodes are provided with single-phase alternating current from the secondary windings of three transformers, the three primary windings of which are energised with current from a three-phase mains supply. The efficiency of such a known arrangement is invariably reduced more or less owing to the fact that the alternating currents in the leads between the transformers and the electrodes induce changing magnetic fields in each other and in the surrounding metallic parts of the furnace, which fields increase the reactance in the said supply leads.

It has already been proposed to reduce this source of inefficiency by taking leads from the transformers in pairs, arranged so as to be inductively compensated, each pair being taken to a branch point as close as possible to the electrodes whence separate, relatively uncompensated, leads are taken to two electrodes.

Hitherto, however, it has not been seen how the lengths of the uncompensated leads could be reduced to the theoretical minimum.

It is an object of the present invention to provide an arrangement which achieves this end, at least more nearly than hitherto.

A further object is to provide an arrangement in which the leads between the transformers and the electrodes are kept away from as much as possible from the surrounding accessories to, and parts of, the furnace which are of high permeability.

With these ends in view, and in accordance with the invention, there is provided an electric arc furnace comprising at least three electrodes disposed respectively along the vertical apical edges of an equilateral triangular prism, a terminal conductor on each electrode for the reception of current leads, inductively compensated leads, arranged in pairs, carrying alternating current to the furnace, each pair reaching a branch point which is located on the cylindrical surface circumscribing said prism, is in a plane bisecting an apical angle of the prism and is in a plane passing approximately through the terminal conductors, from which branch points relatively uncompensated leads are taken to the said terminal conductors. Preferably, also, the compensated leads are disposed beneath a floor lying approximately in the horizontal plane of, or lower than, the level of the clamps.

The difference between the present invention and a known arrangement, and preferred embodiments of the present invention, will now be described with reference to the accompanying diagrammatic drawings in which:

Figure 1 illustrates the theoretically best arrangement of electrode leads for a three-electrode furnace supplied with current from three-phase mains.

Figure 2 illustrates a known approximation to the theoretically best arrangement which has been achieved in practice.

Figure 3 illustrates an arrangement in accordance with the present invention, which enables the leads to be disposed much more closely to the best arrangement in theory.

Figure 4 shows another arrangement in accordance with the present invention as applied to an open furnace.

Figure 5 is a sectional elevation of an arrangement in which the inductively compensated leads are partly or totally supported by or run parallel to the furnace hearth walls.

Figure 6 is a plan view of an arrangement in accordance with the present invention, in which the leads between the transformers and the electrodes are in part constituted by the furnace hearth walls.

Referring now to Figure 1, the furnace comprises three electrodes disposed along the vertical apical edges of an equilateral triangular prism a horizontal section of which is shown at A B C. Current is supplied to the electrodes from the secondary windings of three single-phase transformers, the primaries of which are supplied with current from a three-phase mains supply.

Current flows through the leads between the transformers and the electrodes in the directions indicated by the arrows, and it will be seen that whilst the separate leads are inductively uncompensated, each pair of parallel leads extending between the transformer and a branch point is inductively compensated since these leads are similar, parallel and the current flows through them in opposite directions.

The arrangement illustrated is the theoretically best arrangement so far devised, and it will be noted that each transformer, its compensated leads and the branch points 15, all lie on the bisector of an angle of the equilateral triangle A B C and in the horizontal plane of that triangle, whilst the branch points 15 each lie on the intersection of a bisector of an angle of the triangle A B C with the circle passing through the apices of the triangle A B C. It will be noted further-
more that the triangle ABC is a horizontal section of an equilateral triangular prism, the vertical apical edges of which contain the electrodes 10. Figure 2 illustrates a known form of furnace in which an attempt has been made to approximate to the theoretically best arrangement illustrated in Figure 1.

As before, 10 indicates one of the electrodes dipping into a closed furnace hearth 16 through a roof 17. 18 indicates a charging floor from which the furnace may also be inspected and worked as necessary. 19 is a roof from which the electrode leads are partly supported whilst 30 indicates generally an adjustable support for the electrode 10.

It will be seen that the support 20 carries an electrode aseate 21 which, in turn, carries a terminal conductor in the form of a clamp 22, to which the current leads are electrically connected.

It is not possible to raise the clamp 22 to the height of the compensated leads 14, as, if this were done, that portion of the electrode above the furnace roof would be of no use. If such were the case, it is desirable that the clamp 22 should be mounted on the electrode as close to the furnace roof as possible in order to reduce the length of electrode through which the current has to pass. At the same time the roof 18 must be sufficiently high to allow workmen to stand on the floor 18 and use tools on the furnace without touching the leads above their heads. Consequently, the inductively compensated leads 14 are supported from the roof 18 and are raised to a point 19 whence they are branched into two uncompensated leads each of which comprises a flexible portion 23, ending on a bracket 24 supported from the electrode holder, in series with a water-cooled section 25 connected with the clamp 22.

With this arrangement, therefore, each uncompensated lead extends from the branch point 19 at the height of the roof 18 to the clamp 22 roughly at the level of the floor 18. The sections 23 and 25 of these leads are usually of copper, may be water-cooled, and weigh as much as 10.

Therefore, owing to the necessity for considerable height between the floor 18 and the roof 19, the electrodes 10 require to be unduly long, which again increases their weight.

It will be appreciated that the undute length of uncompensated lead between the point 19 and the clamp 22 in this known arrangement decreases the efficiency of the furnace very considerably.

Figure 3 illustrates the same furnace modified by the incorporation of the present invention. In this arrangement the compensated leads 14 are led up to the furnace beneath the charging floor 18 to the branch point 19 whence separate leads 13 are taken to two electrodes. By this arrangement the branch point 19 can be located roughly in the same plane as the clamp 22 and it is an important feature of the present invention that the compensated leads 14 would terminate just above, in the same horizontal plane as, or just below the clamp 22, for this is the feature which enables the length of the uncompensated leads to be reduced almost to the theoretical minimum.

The further advantages also accrue that the space above the charging floor is practically clear of dangerous electric conductors, the height between the floor 18 and the roof 19 may be reduced so that in turn the length of the electrode 10 may be reduced, and since the length of uncompensated lead 13 is much less, its weight is correspondingly reduced so that the adjustable support for the electrode 10 can be constructed so as to operate with greater speed and sensitivity. Furthermore the branch point 19 lies, as illustrated in Figure 1, on a bisector of one of the apical angles of the triangle ABC or, to be more precise, since the electrodes have length and lie along the apical edges of an equilateral triangular prism of which the triangle ABC is a horizontal section, the branch point 19 is in a plane bisecting one of the apical angles of the prism, is on the cylindrical surface circumscribing the prism and, as indicated above, is roughly in that horizontal plane passing through the clamps 22.

In Figure 4 there is illustrated an application of the present invention to an open furnace. The known apparatus for bringing the current to the electrode 10 is shown in broken lines, being similar to that illustrated in Figure 2, whilst the compensating leads 14 are, in accordance with the present invention, brought up to the branch point 19 within the double floor 18 whence they are connected to the electrodes. Workmen operating upon the floor 18 are protected from the short length of uncompensated flexible lead by a guard 26.

In Figure 5 there is illustrated a closed furnace with the known apparatus for conducting current to the electrode shown in broken lines. In carrying out the present invention, however, as shown in full lines each transformer 12 is located beneath the furnace floor and compensated leads 14 run parallel to the vertical furnace walls. As before, the branch point 19 is located approximately in the plane of the clamp 22.

As shown in Figure 6, the compensated leads of Figure 5 are substituted by two insulated sections of the furnace walls, which are preferably artificial and may, instead of being integral parts of the furnace walls, be carried by the walls.

It will be appreciated that by bringing the compensated leads up to the electrodes approximately at the level of, or beneath the clamp, these leads are kept away from the various metallic parts and accessories of the furnace and that the branch point may be located approximately in the horizontal plane of and close to the electrode clamps thus closely approximating to the theoretically best arrangement.

A reduction of the length of uncompensated leads also permits the use of a wider range of low tension currents to suit the different requirements of the various smelting processes and of the various furnace constructions, whilst the absence of naked conductors above the clamps permits of a more rational distribution of the accessories such as the furnace charging devices around the furnace, thus again increasing the efficiency of the furnace and enabling the charge to be redistributed more equally around the furnace, from which it follows that the life of the refractory lining of the hearth and walls is prolonged.

In the following claims the locations of the various elements of an electric furnace are defined geometrically. It is intended, however, that the claims shall cover furnaces in which the more of the elements are in locations which depart slightly from the exact geometrical location given in the claims where such slight departures are justifiable, for example by constructive difficulties hindering the spacing of the
several elements in the exactly defined locations.

I claim:

1. An electric arc furnace comprising at least three electrodes disposed respectively along the vertical apical edges of an equilateral triangular prism, a terminal conductor on each electrode for the reception of current leads, inductively compensated leads, arranged in pairs, carrying alternating current to the furnace, each pair approaching a side of the said prism and reaching a branch point which is located opposite an electrode on the cylindrical surface circumscribing said prism and passing through said electrodes, in a plane bisecting an apical angle of the prism and is in a plane passing approximately through the terminal conductors, from which branch points relatively uncompensated leads are taken to the said terminal conductors.

2. An electric arc furnace as claimed in claim 1, comprising a furnace floor beneath which the said compensated leads are disposed.

3. An electric arc furnace as claimed in claim 1, comprising three electrodes disposed at the apices of a triangle and provided with three-phase current supply wherein the transformers and branch points lie substantially upon, and the inductively compensated leads are taken along, the bisectors of the angles of the said triangle.

4. An electric arc furnace as claimed in claim 1, comprising means for supporting the said inductively compensated leads, which supporting means are independent of the electrode supports.

5. An electric arc furnace as claimed in claim 1, comprising means for supporting the said inductively compensating leads from the furnace hearth.

6. An electric arc furnace as claimed in claim 1, comprising means for supporting the said inductively compensated leads, which supporting means are independent of the electrode supports, from a floor located not substantially higher than the level of the clamps.

7. An electric arc furnace as claimed in claim 1, wherein the said inductively compensated leads comprise two electrically insulated portions of the furnace hearth walls which are artificially cooled and through which current flows in opposite directions.

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