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ELECTRIC HEATING APPARATUS

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Fig. 1.

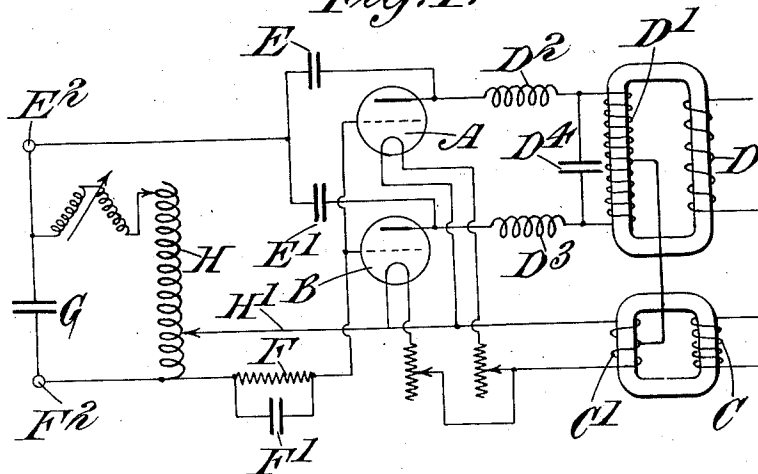
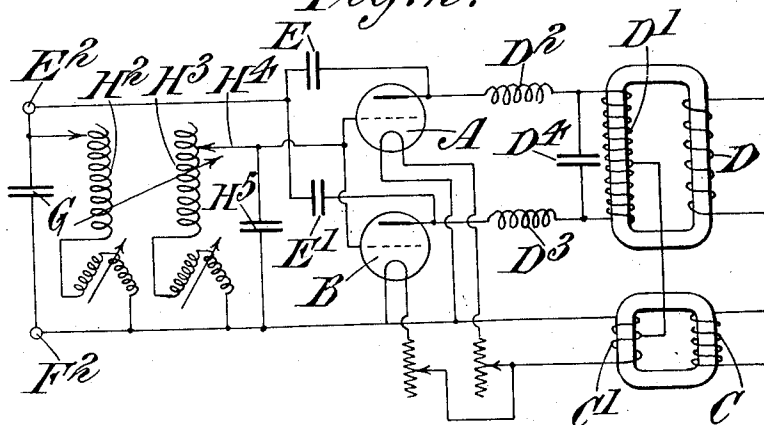


Fig. 2.



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UNITED STATES PATENT OFFICE.

LEWIS COLIN GRANT, OF NEWCASTLE-UPON-TYNE, ENGLAND, ASSIGNOR TO ELECTRICAL IMPROVEMENTS LIMITED, OF NEWCASTLE-UPON-TYNE, ENGLAND, A BRITISH COMPANY.

ELECTRIC HEATING APPARATUS.

Application filed December 22, 1924. Serial No. 757,567.

To all whom it may concern:

Be it known that I, LEWIS COLIN GRANT, a subject of the King of England, and residing at Newcastle-upon-Tyne, in the county of Northumberland, England, have invented certain new and useful Improvements in Electric Heating Apparatus, of which the following is a specification.

This invention relates to heating apparatus employing the principle of electrical induction and has more particular reference to electric heating apparatus for smelting purposes. In such apparatus it is often advantageous to generate the heat for melting either directly in the body to be melted or as near as possible to it, and it is then desirable to use a comparatively high frequency in order to transmit the electric energy economically to the heater.

The present invention has for its object to effect improvements in such apparatus, whereby a high efficiency is obtained more especially in cases where high frequency currents are employed. It is to be understood, however, that the invention is also applicable to cases where a medium or comparatively low frequency is required.

In the apparatus according to this invention a thermionic or other electrical valve circuit is employed to generate the currents supplied to an inductor coil for heating purposes. The inductor coil may itself form part of the oscillatory circuit used for determining the frequency of the currents generated by the valve or valves. Preferably two valves or banks of valves are provided in the generating circuit when an alternating current supply is used and are so arranged as to utilize both halves of the alternating power wave. The anode and grid circuits of the valve or valves may be coupled together either electrostatically or electromagnetically as for example by means of an autotransformer, or alternatively the valves may be excited by means of a "drive" oscillator, which may or may not consist of electrical valves.

The invention may be carried into practice in various ways but a preferred arrangement according thereto is illustrated diagrammatically in Figure 1 of the accompanying drawings, a modified form of this arrangement being shown in Figure 2.

In the arrangement shown in Figure 1

two banks of thermionic valves A and B are employed, only a single valve being shown in each bank of valves in the drawings for the sake of simplicity, these two banks of valves being fed through transformers C C' and D D' from a common A. C. supply. The mid-point of the secondary winding C' of the transformer C C', which is used to supply current to the valve filaments, is connected to the mid-point of the secondary winding D' of the step-up transformer D D' used for feeding the anodes, the two ends of the secondary winding D' being connected respectively to the anodes of the two banks of valves A B, thus utilizing both halves of the alternating power wave. Two choke coils D² D³ are provided, one between each set of anodes and the corresponding end of the secondary winding D', to prevent high frequency energy from the valves from passing into the transformer D D', and a condenser D⁴ is also connected across the winding D' to short circuit any parasitic waves which may pass through the choke coils D² D³. Each set of anodes is also connected through a condenser E or E' to a common wire leading to one of the output terminals E².

The grids of the valves are connected through a grid leak resistance F and condenser F' to the other output terminal F². The two output terminals E² F² are connected together through a tuning condenser G and coil H in parallel, which determine the time constant of the circuit and therefore also the frequency of the currents generated. The coil H is provided with a variable tapping H' connected to the filament circuits of the valves. This coil H thus acts as an auto-transformer, and is itself utilized as the heating inductor coil. It will be understood however that a separate inductor coil may be employed and may be connected across the two output terminals E² F².

The apparatus operates in the following manner. When the filaments are lighted and the high tension supply is applied to the anodes, the anode potential will rise and will cause a current to flow through the coil H and the valves. This causes flux and potential variations in the circuit which are reflected on the grid circuits of the valves, so that the anode and grid circuits operate differentially. An alternating or oscillating

current is thus generated, the frequency of which is dependent upon the time constant of the tuning coil H and the tuning condenser G.

- 5 The single coil H, which acts as an auto-transformer, may be replaced by two electromagnetically coupled coils, if desired, and such an arrangement is illustrated in Figure 2. This arrangement is largely identical
- 10 with that of Figure 1, similar reference letters being employed for similar parts in the two figures, and only those parts which differ from Figure 1 will be described. The output terminal F² is in this arrangement
- 15 connected to the filament circuits instead of to the grid circuits, and the lower ends of each of the two electromagnetically coupled coils H² and H³, which replace the coil H, are connected to this output terminal F².
- 20 The upper end of the coil H² is connected to the output terminal E² and to the anodes, whilst the upper end of the coil H³ is connected through a variable tapping H⁴ to the grids of the valves, a condenser H⁵ being
- 25 connected across from the tapping H⁴ to the output terminals F². With this arrangement, the operation of which will be readily understood from the description given with reference to Figure 1, the coil H² may be
- 30 utilized as the heating inductor coil or a separate inductor coil connected across the output terminals E² F² may be employed, if desired.

The employment of valves according to the invention for generating the heating currents makes it possible so to arrange the impedances in the circuits that maximum efficiency is obtainable.

- It will be understood that the apparatus described and the modifications thereof have been given by way of example only and that other arrangements of circuits, wherein the oscillating currents are generated by means of thermionic or other electrical valves, may
- 40 be employed without departing from the scope of the invention.

What I claim as my invention and desire to secure by Letters Patent is:—

1. An electrical heating apparatus including in combination an inductor coil, and an electrical valve circuit which generates the currents supplied to the inductor coil for heating purposes.
2. An electrical heating apparatus including in combination an inductor coil, at least one thermionic valve for generating the currents supplied for heating purposes to the inductor coil, sources of current for the anode and filament circuits of the valve, and tuning apparatus for determining the frequency of the currents generated by the valve.
3. An electrical heating apparatus including in combination an inductor coil, at least one electrical valve for generating the cur-

rents supplied for heating purposes to the inductor coil the necessary sources of current for the valve, and tuning apparatus of which the inductor coil forms part whereby the frequency of the currents generated by the valve is determined.

4. An electrical heating apparatus including in combination an inductor coil, two banks of electrical valves which generate the currents supplied for heating purposes to the inductor coil, each bank comprising at least one valve, a source of alternating current, means for connecting the valves to the source of current whereby both halves of the alternating power wave are utilized, and tuning apparatus for determining the frequency of the currents generated by the valves.

5. An electrical heating apparatus including in combination an inductor coil, two banks of electrical valves which generate the currents supplied for heating purposes to the inductor coil, each bank comprising at least one valve, a source of alternating current, means for connecting the valves to the source of current whereby both halves of the alternating power wave are utilized and tuning apparatus of which the inductor coil forms part whereby the frequency of the currents generated by the valves is determined.

6. An electrical heating apparatus including in combination an inductor coil, at least one thermionic valve for generating the currents supplied for heating purposes to the inductor coil, sources of current for the anode and filament circuits of the valve, and electromagnetically coupled tuning apparatus for the anode and grid circuits.

7. An electrical heating apparatus including in combination an inductor coil, at least one thermionic valve for generating the currents supplied for heating purposes to the inductor coil, sources of current for the anode and filament circuits of the valve, and tuning apparatus for the anode and grid circuits wherein a single coil acts as an auto-transformer for coupling the two circuits together.

8. An electrical heating apparatus including in combination an inductor coil, at least one electrical valve for generating the currents supplied for heating purposes to the inductor coil the necessary sources of current for the valve, and tuning apparatus of which the inductor coil forms part whereby the frequency of the currents generated by the valve is determined, the inductor coil being arranged to act as an auto-transformer for coupling together the individual circuits of the valve.

9. An electrical heating apparatus including in combination an inductor coil, two banks of thermionic valves which generate the currents supplied for heating purposes

to the inductor coil, a source of alternating current, means for connecting the valves to the source of current whereby both halves of the alternating power wave are utilized, 10
5 and tuning apparatus of which the inductor coil forms part whereby the frequency of the currents generated by the valves is determined, the inductor coil being arranged to act as an auto-transformer for coupling together the anode and grid circuits of the valves.

In testimony whereof I have signed my name to this specification.

LEWIS COLIN GRANT.