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ELECTRICAL APPARATUS

Filed Nov. 3, 1923

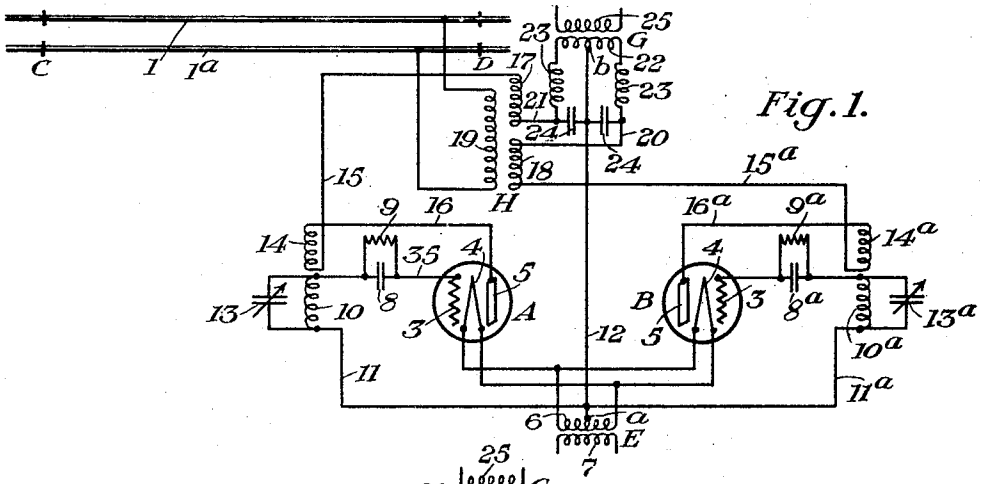


Fig. 1.

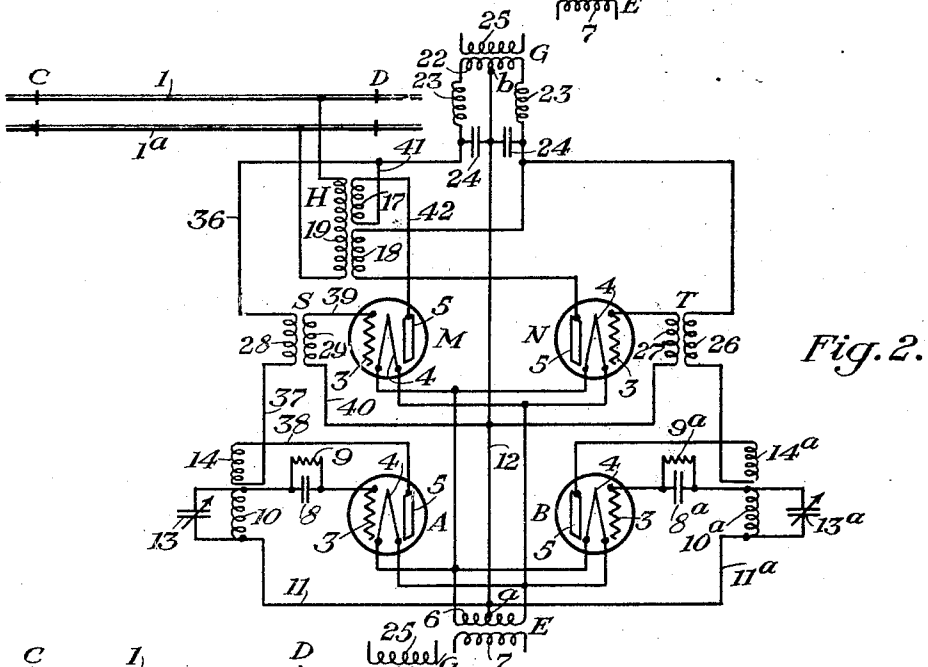


Fig. 2.

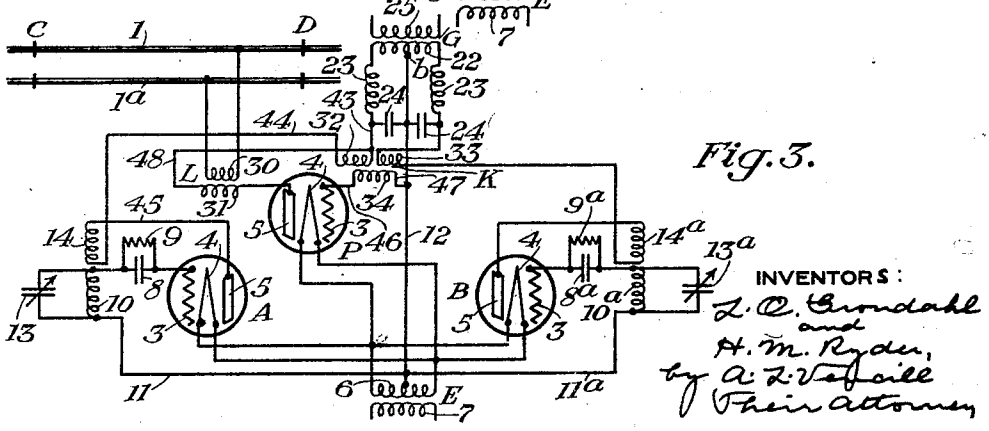


Fig. 3.

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UNITED STATES PATENT OFFICE.

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ELECTRICAL APPARATUS.

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Our invention relates to electrical apparatus, and particularly to apparatus for translating alternating current of a comparatively low frequency into alternating current of comparatively high frequency, and for supplying two such currents of different high frequencies to a single device.

Apparatus embodying our invention is particularly adapted for, though in no way limited to, use in supplying high frequency alternating currents to the rails of a railway in railway traffic controlling systems.

We will describe three forms and arrangements of apparatus embodying our invention, and will then point out the novel features thereof in claims.

In the accompanying drawing, Fig. 1 is a diagrammatic view showing one form of electrical apparatus embodying our invention. Figs. 2 and 3 are views showing modifications of the apparatus illustrated in Fig. 1 and also embodying our invention.

Similar reference characters refer to similar parts in each of the three views.

Referring first to Fig. 1 the apparatus comprises two electron tubes A and B, each having a grid 3, a filament 4, and a plate 5. The filaments 4 of the tubes A and B are connected in parallel across the terminals of secondary 6 of a power transformer E. The primary 7 of this transformer is constantly supplied with alternating current of some convenient low frequency such as 60 cycles per second. The grid 3 of tube A is connected by means of wire 35, grid condenser 8, coil 10, and wire 11 with the mid-point *a* of secondary 6 of transformer E. A high resistance grid leak 9 is connected around the grid condenser 8 in accordance with the usual practice. The grid circuit of tube A may be tuned to resonance at any desired frequency by means of a variable condenser 13 in multiple with coil 10. Tube B is provided with a grid circuit including a grid condenser 8^a, a grid leak 9^a, a coil 10^a, and a variable condenser 13^a, similar in all respects to the corresponding parts associated with tube A.

Electromotive force is supplied to the plate circuit of each tube A and B from a power transformer G, the primary winding 25 of which is constantly supplied with alternating current from some suitable source not shown in the drawing. The plate circuit for tube A passes from the left hand terminal of secondary 22 of transformer G through impedance 23, wire 21, primary 17 of output transformer H, wire 15, coil 14 in inductive relation with coil 10, wire 16, plate 5 and filament 4 of tube A, through both halves of secondary 6 of transformer E in parallel, to mid-point *a*, and wire 12 to mid-point *b* of secondary 22 of transformer G. In a similar manner plate circuit for tube B may be traced from the right hand terminal of secondary 22 of transformer G, through impedance 23, wire 20, primary winding 18 of output transformer H, wire 15^a, coil 14^a in inductive relation with coil 10^a, wire 16^a, plate 5 and filament 4 of tube B, through both halves of secondary 6 of transformer E in parallel to mid-point *a*, and wire 12 back to mid-point *b* of secondary 22 of transformer G. The secondary winding 19 of output transformer H is constantly connected with the device to which it is desired to supply high frequency currents. As shown in the drawing this device comprises the rails 1 and 1^a of a section C—D of railway track.

It will be seen from the foregoing that each of the tubes A and B function as an oscillator in the usual and well known manner. Current flows, however, in the plate circuit of each tube only when the plate of that tube is positive with respect to the associated filament. At any instant however, the relative polarities of the voltages applied to the plates of the two tubes are opposite, and it therefore follows that during one half-cycle of each wave the electromotive force supplied by transformer G, plate current flows through tube A, and during the other half-cycle plate current flows through tube B. The grid circuits of the two tubes A and B are tuned to resonance at different frequencies, so that the high frequency currents superimposed upon the plate circuits of these two tubes have different periodicities. During the half-cycle in which tube A is supplying high frequency current to winding 17, no high frequency current is flowing in winding 18 of transformer H. During the half-cycle in which tube B is supplying high frequency currents to winding 18, no high frequency current is flowing in winding 17. Secondary 19 is, however, in inductive relation with both

windings 17 and 18 and as a result a composite current is supplied to the rails 1 and 1^a. This current consists of a series of groups of impulses, the lengths of all such groups being equal, each alternate group consisting of impulses of one high frequency, and the intervening groups consisting of impulses of a different high frequency. For all ordinary purposes the effect is the same as if two separate alternating currents of these two different frequencies were being continuously supplied at the same time to the section C—D.

A condenser 24 is shown across each half of secondary 22 of transformer G and its associated inductance 23, the purpose of this condenser being to prevent the passage of high frequency currents from the plate circuits upon which they are superimposed, back into transformer G.

Under some conditions of operation it may be desirable to supply to section C—D larger amounts of power than can continually be supplied by single electron tubes of commercial sizes. Under such conditions the output of tubes A and B may be amplified as illustrated in Fig. 2 before being supplied to primaries 17 and 18 of output transformer H. In Fig. 2 the circuits for the filaments and grids of oscillator tubes A and B are the same as in Fig. 1. The plate circuit for tube A however, now passes from the left hand terminal of secondary 22 of transformer G, through inductance 23, wire 36, primary winding 28 of transformer S, wire 37, coil 14 in inductive relation with coil 10, wire 38, plate 5 and filament 4 of tube A, through both halves of secondary 6 of transformer E in parallel to mid-point *a* and wire 12, back to mid-point *b* of secondary 22 of transformer G. In a similar manner primary 26 of transformer T is included in the plate circuit for tube B. The high frequency energy created in the plate circuit of tubes A and B is amplified by electron tube amplifiers M and N, respectively. The filaments 4 of these tubes are connected in parallel across the terminals of secondary 6 of transformer E. Referring particularly to amplifier M, the grid circuit for this tube passes from one terminal of secondary 29 of transformer S, through wire 39, grid 3 and filament 4 of amplifier M, through both halves of secondary 6 of transformer E in parallel, and wires 12 and 40, back to secondary 29 of transformer S. It will thus be plain that during each alternate half-cycle of the electromotive force supplied by transformer G, the high frequency current superimposed upon the plate circuit of tube A will cause a corresponding high frequency electromotive force to be applied to the grid 3 of tube M. The plate circuit of this tube passes from the left hand terminal of secondary 22 of transformer G, through inductance 23, wires 36 and 41, winding 17 of output transformer H, wire 42, plate 5 and filament 4 of tube M, through both halves of secondary 6 of transformer E in parallel and wire 12 back to mid-point *b* of secondary 22 of transformer G. The circuits for tube N are similar to those just described in connection with tube M, it being clear from the drawing that high frequency current superimposed upon the plate circuit of tube B impresses a corresponding high frequency electromotive force upon the grid 3 of tube N, thus creating corresponding high frequency currents in the plate circuit of this tube and hence in winding 18 of output transformer H. It follows therefore that section C—D is supplied with currents having the same characteristics as in Fig. 1.

Referring now to Fig. 3 a single amplifier tube P is used in place of the two amplifier tubes M and N of Fig. 2. The plate circuit for tube A passes from the left hand terminal of secondary 22 of transformer G, through inductance 23, wire 43, primary winding 32 of transformer K, wire 44, coil 14 in inductive relation with coil 10, wire 45, plate 5 and filament 4 of tube A, both halves of secondary 6 of transformer E in parallel, and wire 12 back to mid-point *b* of secondary 22 of transformer G. In similar manner the plate circuit for tube B includes a second primary winding 33 of transformer K. The grid circuit for tube P passes from one terminal of secondary 34 of transformer K, through wire 46, grid 3 and filament 4 of tube P, through both halves of secondary 6 of transformer E in parallel and wires 12 and 47 back to secondary 34 of transformer K. Since winding 34 of transformer K is in inductive relation with both windings 32 and 33 the electromotive force applied to grid 3 of tube P is of the frequency of the high frequency current generated by tube A during each alternate half-cycle, and is of the frequency of the high frequency current generated by tube B during the intervening half-cycles. The plate circuit for tube P may be traced from the left hand side of secondary 22 of transformer G through inductance 23, wires 43 and 48, winding 31 of transformer L, plate 5 and filament 4 of tube P, through both halves of secondary 6 of transformer E in parallel, and wire 12, back to mid-point *b* of secondary 22 of transformer G. Winding 30 of transformer L is constantly connected across the rails of section C—D and the current supplied to this section under these conditions has the same characteristics as with the apparatus shown in Figs. 1 and 2.

Although we have herein shown and described only three forms of electrical apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the

appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In combination, two electron tubes having grid circuit tuned to resonance at different frequencies, a power transformer, an output transformer, a plate circuit for one said tube comprising a first winding of said power transformer and a first primary winding on said output transformer, a plate circuit for said second tube including a second winding on said power transformer and a second primary winding on said output transformer, and a pair of conductors constantly connected with a secondary winding on said output transformer.

2. In combination, two electron tubes having grid circuits tuned to resonance at different frequencies, a power transformer having a secondary of which the mid-point is connected with the filaments of said tubes, means for supplying power alternately to the grids of said tubes, an output transformer, means including a winding on said output transformer for connecting the plate of one tube with one extremity of said secondary, means including a second winding on said output transformer for connecting the plate of said second tube with the other extremity of said secondary, and a pair of conductors connected with a third winding of said output transformer.

3. In combination, a pair of conductors, an output transformer having a first winding connected with said conductors, two electrons tubes, a grid circuit for each tube tuned to resonance at a different frequency and containing a grid condenser and a grid leak, means for heating the filament of each tube, a power transformer having the mid-point of its secondary connected with the filaments of both said tubes; a plate circuit for one said tube including one-half of said secondary, a second winding on said output transformer, and a coil inductively related with the grid circuit of the corresponding tube; and a plate circuit for the remaining tube including the other half of said secondary, a third winding on said output transformer, and a coil inductively related with the grid circuit of the associated tube.

In testimony whereof we affix our signatures.

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